MAR 18 1929

McGraw-Hill Publishing Company, Inc.

March 14, 1929

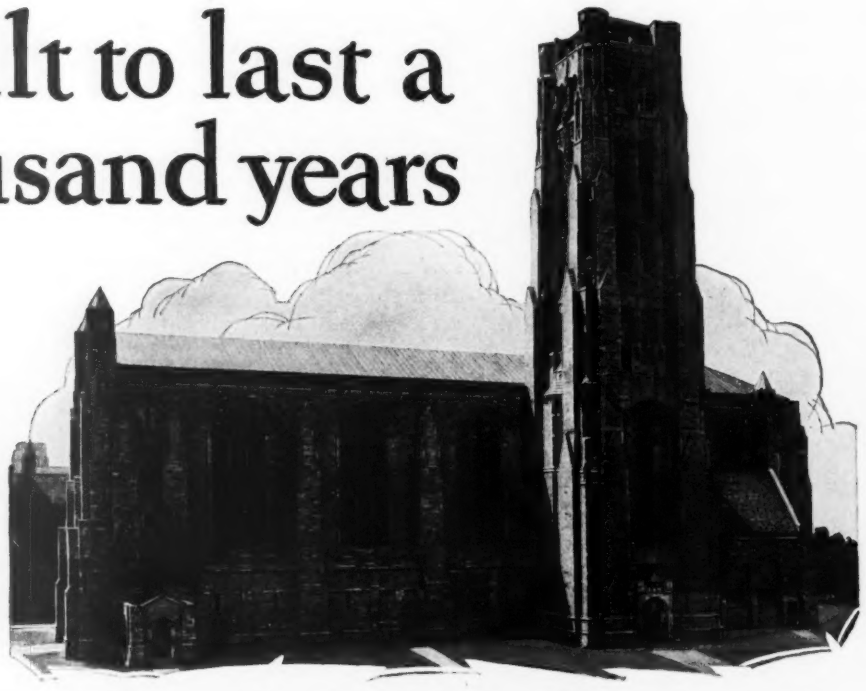
Engineering News-Record

Devoted to Civil Engineering and Contracting

Behavior of Rivers in Alluvial Flood Plains
Engine Terminal and Shops of the Texas & Pacific Railway
Two New Sewage Grit Removal and Washing Installations
Blasting a Trench in Swamp Mat for a Highway Fill
Load Test of Large Model of a Cellular Concrete Arch
Major Provisions of an Arc-Welding Specification
Design and Practical Test of an Integrating Flume Meter
Ingenious Bridge Erection Reduces Falsework
Multiple-Tank Reservoirs at Cincinnati

Mount Airy Tank Reservoir
Cincinnati, Ohio

Built to last a thousand years



University of Chicago Chapel

—and Roofed with Federal

These are the Federal Features

1. *Truly permanent—being stone concrete.*
2. *Fireproof — lower insurance rates.*
3. *Light weight saves steel.*
4. *No maintenance whatever.*
5. *Immune to weather, smoke, gases, etc.*
6. *No rust—no rot—no disintegration.*
7. *Quickly laid in any weather.*
8. *Ready at once for composition covering.*
9. *Smooth under-surface — no painting.*
10. *Lowest cost permanent roof available.*

A greater asset on the books of the company

THE Chapel, shown above, is acknowledged by authorities to be one of the finest examples of Gothic architecture in America. It is built throughout of permanent materials, including the roof of Federal Precast Concrete Slabs. A portion of these are *Nailing Concrete* covered with slate.

Federal Roofs are in universal use today around the country, on public buildings of every nature. A few of them are—Shedd Aquarium, Chicago; Minneapolis Auditorium; University of Michigan Sports Buildings; City Hall, Burlington, Iowa; St. Patrick's Church, Indianapolis; Michigan State Fair Buildings, Detroit; Benjamin Franklin High School, Cedar Rapids; Seattle Theatre, Seattle, Washington.

Numberless industrials and railroads, too, have found Federal Roofs their best investment in permanent, fireproof, no-maintenance service. Send for detail book of Roof Standards.

Made, Laid and Guaranteed by
FEDERAL CEMENT TILE COMPANY
608 *South* Dearborn Street
CHICAGO
FOR OVER A QUARTER CENTURY

FEDERAL
Light Weight Precast Concrete Roof Slabs

New York, March 14, 1929

Engineering News-Record

A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

F. E. SCHMITT, *Editor*

Editorial Staff
New York
V. T. BOUGHTON
Managing Editor
M. N. BAKER
C. S. HILL
W. G. BOWMAN
H. W. RICHARDSON
R. B. GARRABRANT

Editorial Staff
Chicago
E. E. R. TRATMAN
W. W. DE BERARD
On Leave of Absence
San Francisco
N. A. BOWERS

WILLARD CHEVALIER
Publishing Director

Contents

Volume 102, Number 11, March 14, 1929

Multiple-Tank Reservoirs at Cincinnati 414
RESERVE water supply provided by five steel tank and two concrete reservoirs in different parts of the city. By J. A. Hiller

Blasting a Trench in Swamp Mat for Highway Fill 417
INTERESTING blasting procedure developed by dynamiting a channel for fill without excavation. By John A. Johnston

Load Test of Large Model of Cellular Concrete Arch 418
BOX-SECTION hollow rib tested under two-point loading between rigid abutments. By Ralph J. Fogg

Engine Terminal and Shops, Texas & Pacific Ry. 420
FACILITIES at Fort Worth yard include mechanical plants for washing engines and boilers, and steel repair shop.

Two New Sewage Grit Removal and Washing Plants 423
REVOLVING scrapers push deposit in grit chambers to long washing channel equipped with reciprocating rakes.

Major Provisions of an Arc-Welding Specification 425
CODE, adaptable to general use, has been utilized on six recently welded buildings. By Frank P. McKibben

Design of Integrating Flume Meter 428
ELEMENTS of design developed by formula, then tested in field against weir. By J. W. Ledoux

Ingenious Bridge Erection Reduces Falsework 430
METHODS involved bracket falsework and cantilever erection of simple truss span.

Behavior of Rivers in Alluvial Flood Plains 433
OBSERVATIONS indicate that crooked alignment is due to excess of resistance and that shortening is continuous. By Roy N. Towl

Prohibited Parking Raises Traffic Efficiency 435
FOURTEEN months' trial in Chicago found not prejudicial to business and cuts accidents.

Railway Engineers Hold Large Meeting 437
STEEL highway bridge specifications adopted and many other matters of importance considered at Chicago.

The Chicago Sanitary District Dilemma 440
WHAT has been and must be done to meet the situation caused by the Supreme Court decision.

Editorials 411

News of the Week 443

Construction Equipment and Materials 447

McGRAW-HILL PUBLISHING COMPANY, INC., TENTH AVENUE AT 36TH STREET, NEW YORK, N. Y.

NEW YORK District Office, 285 Madison Avenue
WASHINGTON, National Press Building
CHICAGO, 7 South Dearborn Street
PHILADELPHIA, 1600 Arch Street
CLEVELAND, Guardian Building
ST. LOUIS, Bell Telephone Building
SAN FRANCISCO, 883 Mission Street
LONDON, 6 Bouverie Street, London, E. C. 4

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, JR., Vice-President and Treasurer
EDWARD J. MEHREN, Vice-President
MASON BRITTON, Vice-President
EDGAR KOBAK, Vice-President
HAROLD W. McGRAW, Vice-President
C. H. THOMPSON, Secretary

Publishers of
American Machinist — Engineering News-Record
Power — Chemical and Metallurgical Engineering
Coal Age — Food Industries — Radio Retailing
Engineering and Mining Journal
Ingeniería Internacional — Electric Railway Journal
Bus Transportation — Electrical Merchandising
Electrical World — Construction Methods
Electrical West
(*Published in San Francisco*)
American Machinist—European Edition
(*Published in London*)

SUBSCRIPTION PRICES: United States and its possessions, Canada, Mexico, and other countries taking domestic postage rates, $5 a year. All other foreign countries, $9 a year. Single copy, 25 cents. Published weekly. Entered as second class matter, April 11, 1917, at the Post Office, New York, N. Y., under the act of March 3, 1879. Printed in U. S. A.

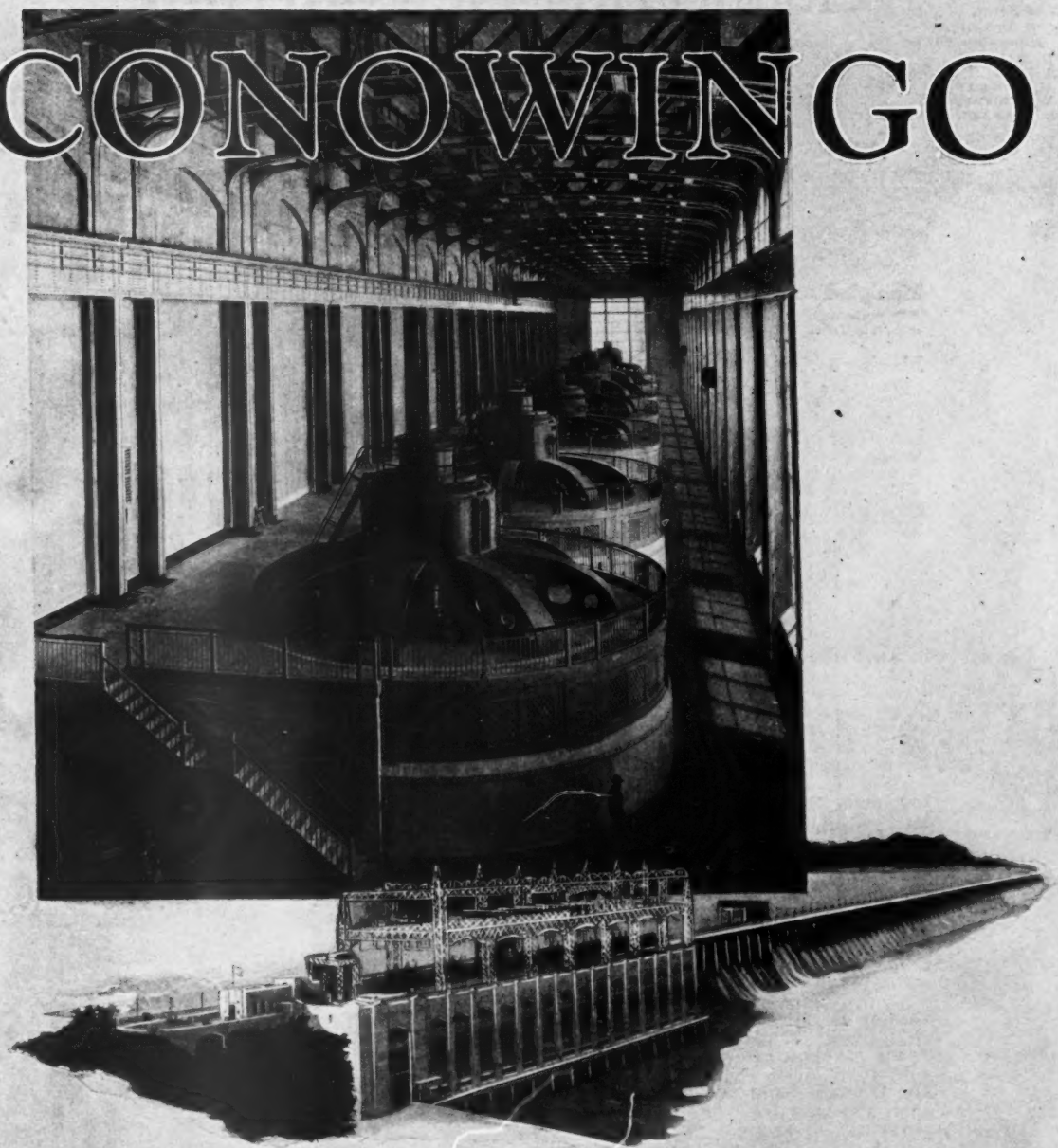
Copyright, 1929, by
McGraw-Hill Publishing Company, Inc.

CHANGE OF ADDRESS
Subscribers are requested to send both the old address and the new address when they move to a new address.
Member—Audit Bureau of Circulations.
Member—Associated Business Papers.

Construction Market Place, 196 **Searchlight Section 147** **Index to Advertisers, 204** **Directory of Consulting Engineers, 192**

Number of Copies Printed This Issue, 31,956

CONOWINGO



Largest Block of Power, either steam or hydro, ever installed in one operation. Finished six months ahead of schedule.

Stone & Webster, Inc., designers, builders, and consulting engineers

STONE & WEBSTER
INCORPORATED

OPERATE FINANCE BUILD

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGRAW-HILL PUBLISHING COMPANY, INC.
JAMES H. McGRAW, *Chairman of the Board*
MALCOLM MUIR, *President*
EDWARD J. MEHREN, *Vice-President*
F. C. PARMELEE, *Editorial Director*

F. E. SCHMITT, *Editor*

WILLARD CHEVALIER
Publishing Director

Volume 102 NEW YORK, MARCH 14, 1929 Number 11

An Obstacle Removed

UTAH'S ratification of the Colorado River compact, reported this week, establishes one necessary preliminary to progress of the Boulder Canyon storage development. Some years ago six of the seven basin states —all except Arizona—ratified the compact for division of the river's flow subject to ultimate ratification by all seven states. Later, qualifications were made by California and by Utah, the latter directed against any attempt to put the compact in force on a six-state ratification alone. Now both California and Utah have made unreserved ratification of the compact. Accordingly, under the terms of the Boulder Dam act recently passed by Congress the development of the river can go ahead even without Arizona's ratification, after six months from the passage of the bill, a time not far in the future. The remaining problem is the execution of contracts with applicants for the purchase of water or power to an amount covering the cost of the enterprise. But at least the vital preliminary of state ratification is now an accomplished fact.

A Significant Vote

TWO long-discussed enterprises of great magnitude went through initial proceedings this week in a decision of the Board of Estimate and Apportionment of New York City to proceed with the Tri-borough bridge and the Narrows tunnel. The former would connect Queens, Manhattan and Bronx boroughs along a course roughly parallel to the famous Hell Gate railroad route. The Narrows tunnel is to provide a connection between the boroughs of Brooklyn and Richmond (Staten Island). More significant than the size of the projects —they will total more than one hundred million dollars in cost—is the fact that they are planned as public toll structures, traffic tolls being collected to refund the bonds issued for their construction. Pending the passage of enabling legislation by the state, which is expected, it is timely to note that these two projects represent the largest municipal undertakings in the toll-refunding field. They are a strong expression of the present drift toward the public toll plan of providing traffic improvements and similar facilities by paying for them out of the pockets of users. The plan appears to have a large future before it.

Prequalification Laws

LEGAL authority to require prequalification of bidders on public works construction in New York is sought in an act amending the public-works law and the general municipal law of that state. This act has the support of the city engineers' association, the state department of public works, and the state highway chapter of the Associated General Contractors. It is merely an enabling law. Option is with the contracting official on state public works and with the municipal legislative body on city public works. The act is interesting especially because it is the first attempt at legislation. At present some thirty state highway departments, one or two federal bureaus and perhaps a score of cities are calling for prequalification of bidders. The expression of opinion is that benefit has resulted to the public and that no injustice has been done to contractors. However, the legality of the practice has remained in doubt; hence the present attempts to give it express sanction of law—the act now before the New York Legislature, the act being considered in Oregon and the standard registration act being worked out by the Associated General Contractors. In all these proposed laws the very serious responsibility of deciding contractor qualification is put on the contracting official—in final analysis the engineer—with no definition of qualification to govern him. This is wide liberty and in practice has to be limited by a clear conception of contractor qualification and by an express definition in the call for bids. Handicaps should be stated before the contest begins. The authorizing legislation is not the place to set them forth, but the engineer who executes the authority of the law has a definite obligation to be specific. There are clear indications that contractor prequalification acts are going to be written into our laws. It is well that they should be. Let it also be remembered that they put on engineers the duty of setting up fair and effective procedure for applying them.

Welding Information

KNOWLEDGE of the design principles of fusion welding of structural steel is gradually being increased. What is no less important, this knowledge is being more widely disseminated. The large arc-welded structures erected in the past few years have, by and large, been conservatively and carefully designed. But many smaller welded structures are standing in spite of their design rather than because of it. This situation can be satisfactorily cleared only by a wider appreciation of proper design brought about by a sustained growth in the literature of welding. Happily, such a growth is becoming apparent. At the last convention of the American Institute of Steel Construction Fred T. Llewellyn, president of the American Welding Society, read an important paper which collated and brought up to date our present knowledge of structural welding; this paper will be published in a near future issue of this journal. The structural steel welding committee, which has carried out a remarkable program of tests on welded joints, will soon issue its long-awaited specification. In this issue there is published an electric-arc welding specification prepared by Frank P. McKibben, planned to benefit those engineers who have been handicapped because of lack of information, and also to guide the framers of city building codes and others who are considering the adoption of arc welding. As the first specification of its kind it forms an important contribution to the available literature on the subject and deserves wide attention. In these

several ways is the literature of structural welding assuming the proportions that are necessary for the proper development of the art. Obviously welding is not to be expected to replace riveting altogether; certainly it is not a panacea for all the present-day ills of the structural designer and fabricator. But it has demonstrated its worth as a process worthy to be included in the structural engineer's kit bag, and therefore the profession cannot afford the setback to its acceptance that failure of a poorly designed structure would inevitably bring about. One of the surest safeguards against this is a wide appreciation of sound and careful design.

Ingenuity

EVEN a highly perfected art offers continued opportunity for new thought. Witness the article in this issue describing two ingenious schemes for erecting steel truss bridges with a minimum of river falsework. Other bridge work now under way lends further assurance that the engineer has not yet become a standardized and packaged article. At Cincinnati the new double-track Chesapeake & Ohio Railway bridge over the Ohio River, a three-span continuous truss, is being erected by locomotive cranes with booms up to 145 ft. in length. At Louisville the Big Four is using its old E-30 bridge as falsework for its new E-70 structure, involving ingenious strengthening details for the old truss and highly original design for the new work. Also at Louisville a cantilever highway bridge is being erected by guy derricks—first used to erect the tall bents on and adjacent to the piers and then jumped to a small movable carriage on the floor of the bridge. No power unit is carried on the structure, hoisting and traveling lines being led to a barge carrying that most versatile of machines, the crawler tractor, to which a three-drum hoist is connected by gears and chains. Perhaps bridge building offers more opportunities for initiative than some other fields, but it nevertheless has experienced periods of contentment and satisfaction with things as they are—for instance, the period when a special traveler was considered indispensable for erection of large spans. The recent developments again prove that practice, however good, is always susceptible of improvement, and that opportunities for ingenuity are never lacking.

Road Centralization

CENTRALIZATION of highway control is approved by an overwhelming majority in the referendum vote of the U. S. Chamber of Commerce on state and local road administration. It may well be questioned how far the vote reflects independent thinking and not perfunctory assent to a committee recommendation; the fact is, however, that the vote commits the chamber to a definite doctrine of highway administration. Undoubtedly in its action the chamber falls into step with the march of recent years. Since federal aid became a factor in highway improvement there has been a steady advance toward centralization of authority, particularly in the states, and to a reflected degree in the counties. Over all, whenever federal aid has had a part in improvement, there has been the domination of the bureau in charge of the national highway expenditure. Of the benefits of this centralization there is no question so far at least as the states are concerned. But these benefits are largely in the better handling of the technical problems of road construction, and in a lesser degree of road maintenance. With full recognition of what has been accomplished for better highway management there remains the question how much will further centralization be of public benefit. The Chamber of Commerce by its vote commits itself to the doctrine that the local units of township and county should be shorn of virtually all control over their public roads and that this control be vested in the state. There is a considerable body of opinion that state control should not be the limit of centralization—that for the national roads, at least, full authority should be concentrated in the federal government. Yet it is easy to see that bureaucracy in highway administration has had some objectionable results, which must not be overlooked. Many implications of the present stampede toward centralization of public-roads administration demand serious thought. What is to be limit in centralization of highway control? The ultimate answer is still to be given; but in any event it cannot be found through mere drifting with the general current of the moment.

Our Shortening Rivers

HYDRAULIC engineers have long been divided for and against the desirability—or necessity—of keeping a river crooked by preventing cutoffs at the necks of bends, a subject ably discussed this week by R. N. Towl. Briefly, Mr. Towl's contention is that a river's natural course is the shortest distance to its mouth, hence it would be a straight course did not local resistances keep it crooked. These latter include both natural agencies such as topography, vegetative growth, rafts, hard deposits and islands, and man-built structures such as levees, revetments and spur dikes.

Examples are cited to show that many rivers in alluvial beds, not alone the Mississippi, are straightening themselves. Geologically speaking, the action is rapid; humanly measured, of course, it is rather slow. Whether active steps to accelerate this straightening are desirable, now that man has entered the landscape and has built his houses and structures along the existing alignment, is a question which the author leaves in part to the economist, in part to the conclusions which may be obtainable through further detailed surveys. He limits himself to emphasizing the reality of the natural tendency of rivers to go along a straight and not a crooked course.

Once the basic conception is established—and soundly established—one may then proceed to theorize on how to work in co-operation with the river rather than against it. In other words, if the natural tendency is to shorten and straighten—the water always seeking the most direct course to its outfall—any properly planned straightening works should be easy to maintain. In any given case, however, all factors must be taken into account. It may be far more desirable to maintain and save taxable property alongside existing river banks, such as the town of Greenville, Miss., than to eliminate the Greenville bends, which action, as Mr. Towl well points out, would transfer an undue amount of energy and congestion downstream. River straightening can be done only on a progressive program taking into account the whole length.

The subject is thought-provoking. It seems as though Mother Nature had been a little slow in getting the valley of the Mississippi ready for human habitation. Had man appeared on the scene several centuries hence, or had he (as on some stretches of the Missouri) removed only local obstructions and not attempted to control the flow by levees, the stream would eventually have become

straight, deep and perhaps wide enough to carry maximum floods.

Mr. Towl's article does not traverse present-day practice in the way that might be assumed from a hasty reading. It does, however, indicate that there is need for very definite study of the major hydraulics of the river.

Chicago's Problem

CHICAGO faces a crisis. None greater has confronted any city in modern times. For decades it has built its affairs on the assumption that it was free to order its water supply and sewerage as it chose, without regard to the rights claimed by others; now, by mandate of the highest authority, the United States Supreme Court, it is ordered to abandon that course; the terms of the order are to be detailed within a few weeks. The occasion finds the city unready.

Unreadiness lies not only in incomplete physical accomplishment and lack of finished plans to make up the deficiency but also in mismanagement and financial embarrassment of the Sanitary District of Chicago. Unreadiness is increased by lack of confidence in the trustees of the district on the part of the voters, whose approval of further bond issues is required.

What has the Sanitary District of Chicago done to meet a sewage-disposal condition which has been growing more serious for twenty years past and has reached a critical stage with the Supreme Court decision? Since 1908 it has conducted experiments on both laboratory and working scale that have shown what methods of sewage treatment are best suited and how they can best be applied to the sewage of the district. It has constructed sewage-works which combined are designed to treat, to varying degrees of completeness, the sewage of nearly 3,000,000 population, or an equivalent of half to two-thirds that population on a 100 per cent basis; but the combined sewage and industrial wastes in 1945 are estimated to be equivalent to the sewage of from about 7,000,000 people. This construction work has entailed a capital outlay, including interest paid on bonds, of considerably more than $200,000,000, of which well toward half has been for treatment works and accessories and the remainder for the original program of disposal by dilution. As to water treatment, not a dollar has yet been spent by Chicago except a small capital outlay for chlorination equipment and for an experimental purification station. Nor has much been done toward the complete metering of the water supply, which had been made a condition of the 1925 lake diversion permit of the Secretary of War. All that the conditional permit demanded be done to date in the way of sewage and water treatment appears to have been done; but the latest Supreme Court decision will require so much more than the Chicago officials expected as to make the present state one of unreadiness physically and unpreparedness even as to plans.

Just what will have to be done in water-supply and sewage-disposal construction, and in how short a time, awaits the findings of Charles Evans Hughes, who is to give a hearing on March 25 preparatory to submitting recommendations to the Supreme Court on which the latter will base its decree to carry out its decision of January 14 that the Sanitary District may divert no water from the Great Lakes to the Mississippi drainage basin for purposes of sanitation *per se*.

It seems safe to assume, whatever time may be given to do the work, that the entire sewage of the Sanitary District and the water supply of Chicago will have to be treated to the highest state of the two arts, including chlorination. Under any but the extraordinary conditions that have been created at Chicago, a balancing of cost and expediency between sewage and water treatment might be expected; but at Chicago the only balancing seems likely to arise from the difficulties inherent on the one hand in turning even the highest possible grade of sewage effluent through the drainage canal with no dilution except the runoff from the 300-mile drainage area of the Chicago River and on the other hand in turning some of the effluent into the lake and therefore pushing the water-supply tunnels to points more remote from the possible effect of sewage effluent discharge.

Responsibility for the unprecedented situation at Chicago attaches to many factors in addition to the present financial embarrassment of the Sanitary District. There were almost no sewage-treatment plants in the United States when Rudolph Hering proposed and others indorsed disposal by dilution in 1887. Water treatment was little farther advanced. An error of far-reaching effect in the light of later events was committed when Chicago and Illinois assumed that water could be diverted from one great drainage basin to another without a federal permit, which was obtained only just before the canal was opened in 1900. Sewage disposal, though planned for the protection of the city's water supply, was vested in a district organization, governmentally independent of the city, while the water supply itself was left in charge of the city authorities; the latter stood idly by, so far as the general march of water treatment was concerned, provided no water treatment except chlorination, and operated the chlorination plants negligently until disastrous results forced reform. Moreover, mixed motives have affected the sewage-disposal and water-supply problems of Chicago, because for 65 years there has been some measure of association between lake diversion for sewage disposal and a lakes-to-gulf waterway, in later years involving also the purpose of hydro-electric power generation.

In full consideration of all these factors, the primary responsibility for the present situation at Chicago rests upon engineers. All through the history of the case it was they who recommended or sanctioned the major developments. With the advance in the art of sewage treatment and with the Lake states fighting to protect navigation, a far stronger demand for sewage-works construction and for a higher degree of treatment should have come from them.

Last but not least among the factors that complicate Chicago's present stupendous problem is a partisan bitterness that has degenerated into a veritable persecution complex. Many Chicagoans—even engineers not connected with the city, district or state affairs—appear joined in an obsession that the rest of the country wants to stop the city's growth, even at the sacrifice of the health of its citizens. Getting rid of this obsession would go a long way toward bringing Chicago to grips with its great sanitary problem, the greatest of the age.

The way out of the present evil situation must be found through a definite and strong technical program that will face the facts squarely through reorganization of system, courageous financing and energetic execution of the program. It needs energy and clear vision in supreme degree. Chicago's proud motto "I Will" is put to crucial test by the undertaking.

Multiple-Tank Reservoirs at Cincinnati

Reserve Water Supply Provided by Five Steel Tank Reservoirs and Two Concrete Reservoirs in Different Parts of City—Masonry Casing With Architectural Treatment

By J. A. Hiller
Superintendent, Cincinnati Water-Works, Cincinnati, Ohio

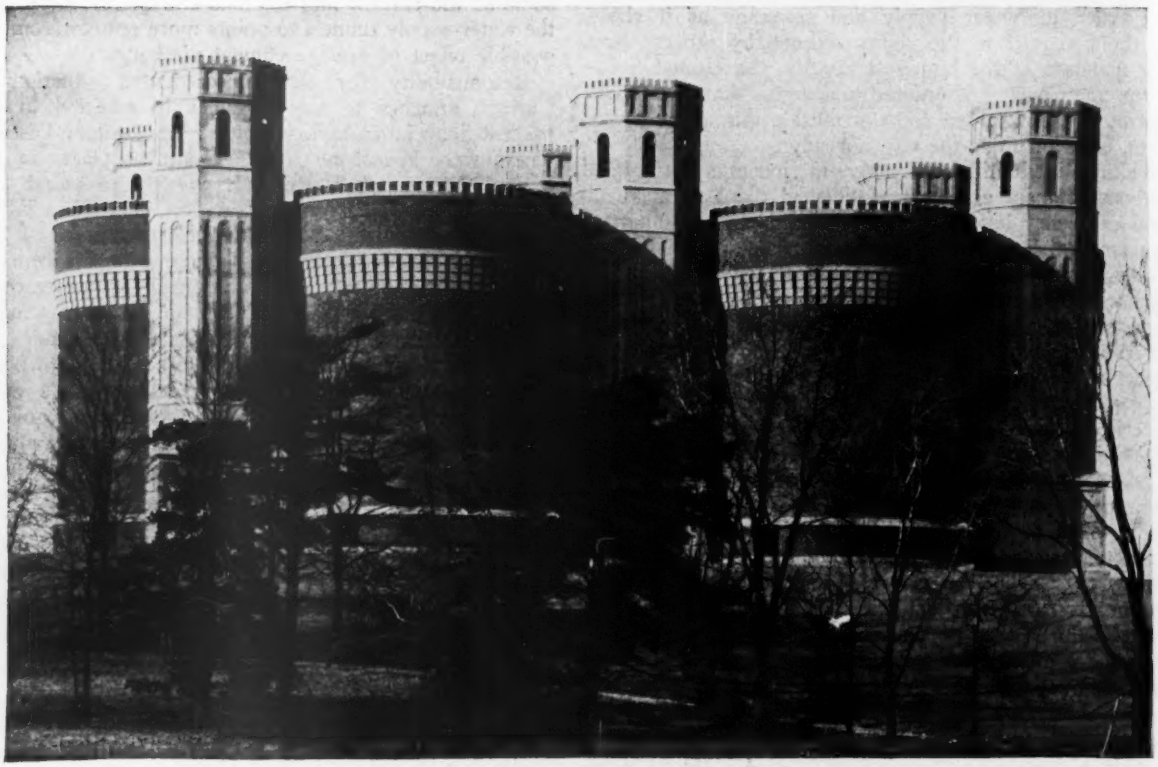


FIG. 1—MOUNT AIRY TANK RESERVOIR, CINCINNATI, OHIO
Wall incloses fourteen steel standpipes with combined capacity of 8.5 m.g.

A PROMINENT feature in the water-supply system of Cincinnati, Ohio, is the use of groups of large steel standpipes in high-level sections of the city. The reserve storage thus provided, combined with ample pumping capacity, insures continuous supply to these sections in case of any interruption to the main supply. Particularly interesting is the inclosure of these tanks with walls of architectural design to mask the bare steel tanks. The most recently built reservoir of this type, on Mount Airy, is shown in Fig. 1.

Water-Supply System—The water supply of Cincinnati is taken from the Ohio River on the Kentucky side about 7½ miles above the business center of the city, where there is comparatively little local pollution and where the greater depth of water on the far side insures against interruption of the supply during times of minimum low water. From the intake tower a 7-ft. tunnel leads to the river pumping station on the Ohio bank, where the water rises in a shaft serving the suction headers of four 30-m.g.d. pumps, which discharge through two 60-in. mains into two settling basins having a combined capacity of 340 m.g. These basins also form a reserve in case of any interruption to the supply. From them the water flows by gravity through the 100-m.g.d. purification plant (average daily consumption, 50 m.g.) and into a 19-m.g. clear well, which forms a second, though small, reserve.

From the clear well water flows through a 7-ft. concrete-lined tunnel, 4½ miles long, in bedrock and at an average depth of 150 ft. to the main pumping station. This tunnel connection was adopted as a means of insuring uninterrupted supply, in preference to lines of mains near the surface and subject to the contingencies of a shifting river valley.

Distribution and Reserve Supply—Owing to the diversified topography of the city, it is necessary to divide the distribution system into three districts: (1) the Eastern Hills service for the high ground east of the Mill Creek valley; (2) the Western Hills service for the hills west of the valley; (3) the Central service, which includes the business section, the Mill Creek valley and the low ground adjacent to the river. At the main distribution pumping station the pumping units are divided into two groups, one for the Eastern Hills service and

the other for the Central service. The Western Hills district is served by a second pumping from the mains of the Central service.

It has always been the policy of the water department to provide a liberal reserve in the pumpage capacity and a reserve in elevated storage reservoirs and tanks, sufficient to last over the time required to make ordinary repairs to force mains or to pumping machinery. In addition to the insurance of a more nearly continuous supply, this policy has the added economical advantage of operating the pumps at a more nearly uniform rate, since pumpage neeed not exactly follow the varying rates of consumption. The maximum demands or peak loads can be drawn from storage, made up at times of lesser consumption. The city now has in each of the districts or

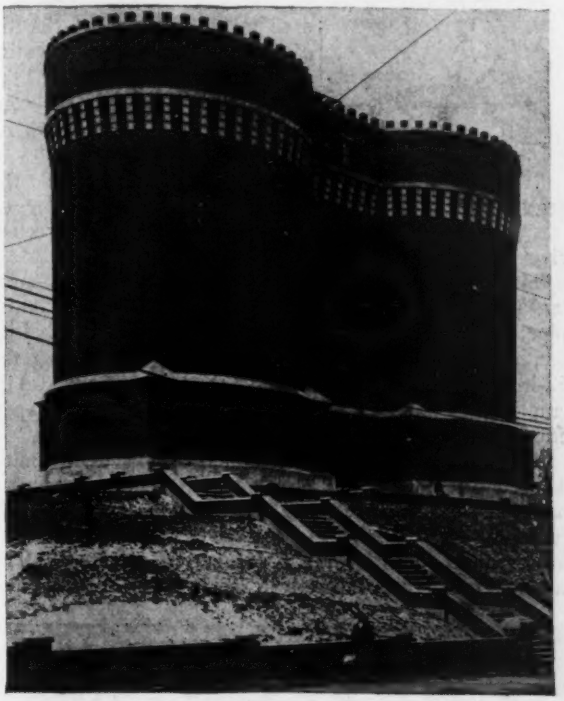


FIG. 2—MOUNT AUBURN RESERVOIR, TWO STANDPIPES

services a reserve supply for at least two days of average consumption.

Reserve for Central Service—The reserve supply for this district is contained in the Eden Park reservoir, placed in operation in 1878. This is an open reservoir, situated in a natural valley, the lower end of which is closed by a masonry dam 125 ft. high. Since its construction there has been considerable leakage through the bottom and the side slopes. The east basin was relined with reinforced concrete in 1923 and the west basin with reinforced gunite in 1925, which has practically stopped the leakage. The total capacity is 96 m.g., equal to three days' average consumption, and more than two days' maximum demand in the Central territory.

Reserve for Eastern Hills—The reserve supply for the Eastern Hills service is contained in two groups of standpipes and a concrete reservoir. The Mount Auburn group consists of two steel tanks 40 ft. in diameter and 70 ft. high, which were erected in 1894 on a masonry foundation. Being in a high-class residential district, plans were made in 1923 to improve the appearance by surrounding the steel work with concrete and brick

FIG. 3—EASTERN HILLS RESERVOIR
Five steel standpipes with combined capacity of 4.7 m.g.

masonry and also to line the interior with reinforced gunite. This tank reservoir (Fig. 2) now presents a pleasing appearance and has enhanced the value of the adjacent property. Its capacity is 1.3 m.g. The Eastern Hills group (Fig. 3) consists of five 40x100-ft. standpipes, incased in reinforced concrete to resemble towers and having the interior lined with reinforced gunite. They have a total capacity of 4.7 m.g.

The Eastern Hills reservoir is a reinforced-concrete structure 400 ft. square, with 30 ft. depth of water and a storage capacity of 35, m.g. Thus the combined storage for the Eastern Hills service is 41 m.g. equal to two days' average consumption in this territory.

Reserve for Western Hills—The reserve supply for the Western Hills service is contained in two groups of of standpipes: the Western Hills group and the Mount Airy group, the latter being completed in 1927. The Western Hills group (Fig. 4) consists of four 35x65-ft.

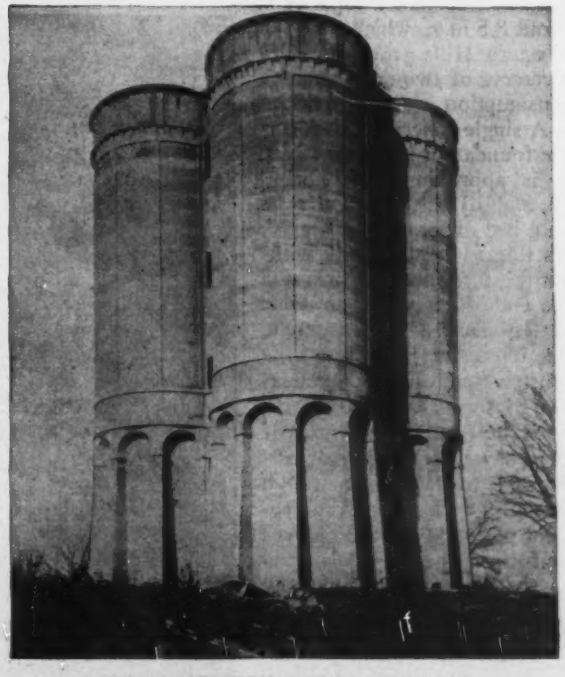


FIG. 4—WESTERN HILLS RESERVOIR
Four concrete-cased steel tanks on concrete base 35 ft. high.

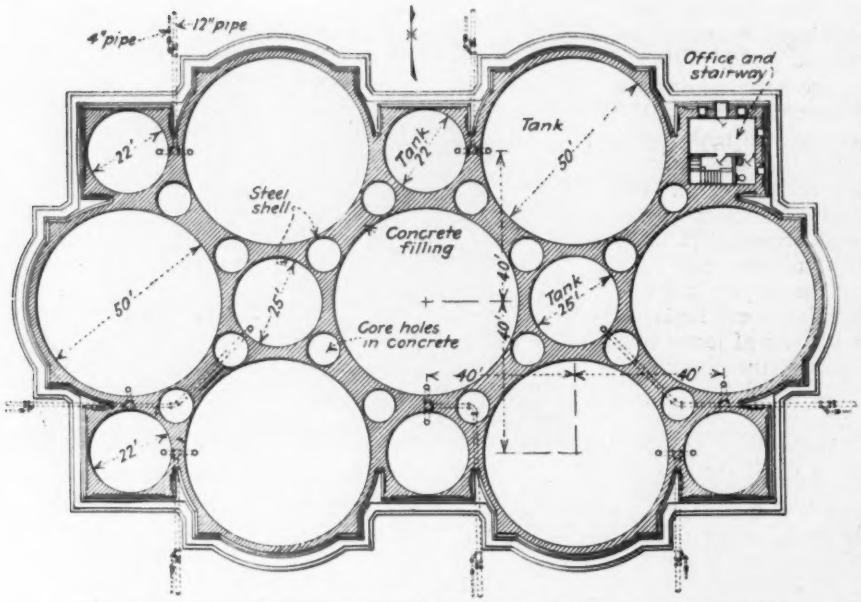


FIG. 5—ARRANGEMENT OF STANDPIPES IN MOUNT AIRY RESERVOIR

tanks on a concrete base 35 ft. above the ground surface. They are incased in reinforced concrete and present a pleasing appearance. The interior has been lined with reinforced gunite, thus entirely incasing all steel in masonry and eliminating the work of cleaning and painting every few years. These four tanks hold 1.3 m.g.

Mount Airy Multiple-Tank Reservoir—This latest of the reserve supply reservoirs, shown in Figs. 1 and 5, is perhaps the largest existing group of tanks or standpipes ever built on a single foundation. The site, on the highest ground within the county, permitted of large diameters with moderate height. There are fourteen tanks in all: seven are 50 ft. in diameter, two are 25 ft. and five are 22 ft.; all are 70 ft. in height, arranged as shown in Fig. 5. Their combined capacity is about 8.5 m.g., which with the Western Hills group provides a reserve of two days' average consumption in this district.

A single concrete slab forms the foundation for these tanks. It is approximately 220x140 ft., and 10 ft. thick, and rests on a bed of stratified material. As this foundation was without reinforcement, it permitted the embedding of large stone in the mass of the concrete. An interesting feature of its construction was the elimination of forms. As the specifications permitted the use of large stone, the contractor was allowed to lap up a rough masonry wall in portland cement mortar, the exterior lines conforming to the dimensions of the foundation. Concrete was then deposited within the inclosed space. This plan saved the cost of making, erecting and removing forms, while the backfilling outside could proceed as rapidly as the concrete was placed.

The steel shells was designed to carry the water pressure independently of the surrounding concrete and brickwork or the inner lining of gunite, these latter serving only as protection to the steel and for architectural effect. The bottom and the two lower courses of each tank were erected on blocking about 5 ft. above the foundations. After riveting and calking, a test was made for watertightness. These bottom sections were then lowered to within 3 in. of the top of the foundations. The entire space between the bottom of the tanks and the top of the concrete was then poured full of cement grout, through holes in the bottom and around the perimeter. The remainder of the steel work was then erected, riveted, calked and tested.

The tanks are operated in pairs, a large and a small tank being controlled by a single 12-in. inlet and outlet pipe, in which is placed a 12-in. valve and a 12x4-in. tee, with a 4-in. valve on the branch. By closing the 12-in. and opening the 4-in. valve the pair of tanks can be emptied, but in the normal condition the former is open and the latter is closed.

The exterior of the 50-ft. tanks is faced with multi-colored brick, laid in Flemish bond, the annular space between the steel shell and the brick being filled with concrete. The brickwork is relieved with base course, belt courses, corbels and a parapet of concrete. The smaller tanks are incased in concrete, the lines and

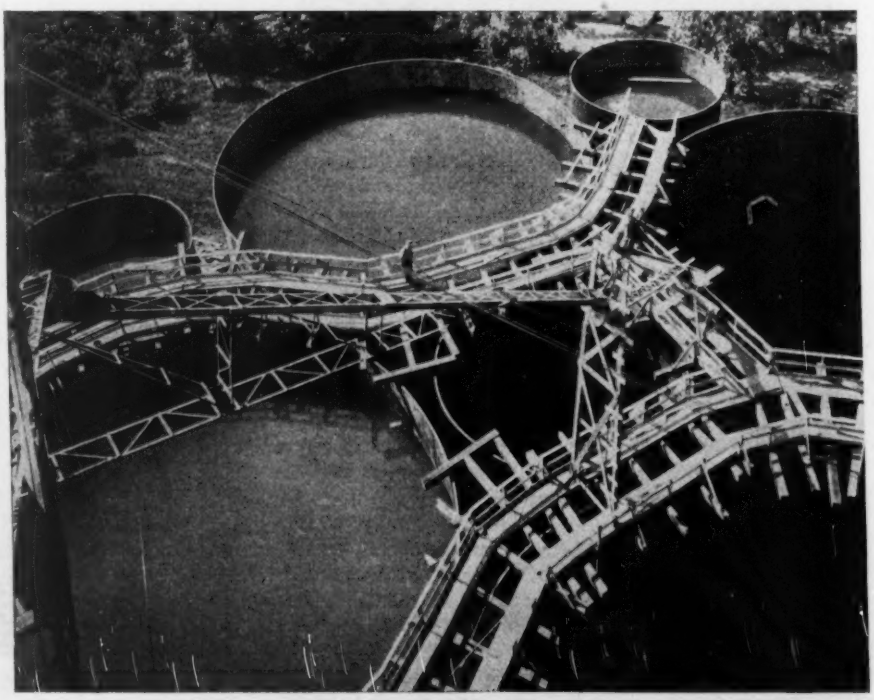


FIG. 6—CONCRETING THE MOUNT AIRY STANDPIPES

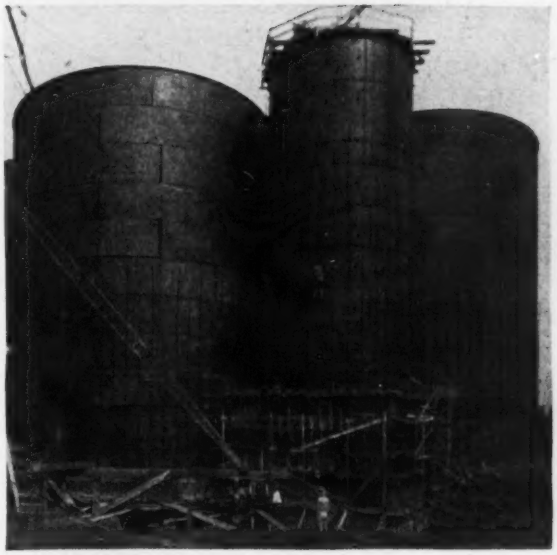


FIG. 7—PLACING STEEL FOR CONCRETE CASING

surfaces being relieved by belt courses, panels and parapets. All showing faces of the concrete are wire brushed, treated with dilute acid, washed and plastered. No tank was placed in the northeast corner, this space being utilized for an office for the gagemen and a stair gallery to the top of the structure.

Concrete was filled into the space between the tanks, thereby entirely incasing all steel work, as shown by Fig. 5. Where this space was large, core holes were left in the concrete, but in no case was the concrete surrounding the tanks less than 9 in. thick. These core holes were covered with the upper walk slab, excepting one which serves as a drop manhole for the drainage of the roof and the overflow from the tanks. The concrete filling between the tanks was stopped 30 in. below the top of the tanks and received a sidewalk finish, to serve as an observation platform.

All the tanks were lined with 2 in. of gunite, reinforced with 2x2-in. wire mesh, fastened to the steel sheets with clips electrically welded thereto. No part of the steel is exposed, the entire surface being covered with concrete or gunite, thus giving the steel a protective coating that will require little or no maintenance. Fig. 7 shows the placing of steel reinforcement around the tanks. Fig. 6 shows the concreting in progress, the tanks being full of water at the time.

Designers and Builders—The Western Hills tanks were erected during 1911 and 1912 by the L. Eid Construction Company, and the Eastern Hills tanks in 1914 by the Ferro Concrete Construction Company. The remodeling of the Mount Auburn tanks was done in 1924 by the Indiana Construction Company. The Eastern Hills concrete reservoir was built during 1924 and 1925 by the Max Penker Sons Company. The Mount Airy tanks were erected in 1926 and 1927 by the Hodges Construction Company. All of the above-mentioned structures were designed and supervised by the writer as superintendent of the Cincinnati Water-Works.

Blasting a Trench in Swamp Mat for Highway Fill

Dynamiting Opens a Channel for Fill Without Excavation—Interesting Blasting Procedure Developed

By John A. Johnston

District Highway Engineer, Department of Public Works, Boston, Mass.

In building highways in central Massachusetts occasional deep swamps are encountered, most of which are full of fibrous roots, fallen wood and grasses, forming a mattress that will partly support a fill but will slowly subside, necessitating frequent maintenance, so that only for short periods is the road in proper condition for comfortable and safe travel. To insure stability in these places it is necessary either to excavate the fibrous muck and replace it with solid dirt or so to break up these fibers with explosives that the embankment may reach a solid bearing. The latter method was used in 1928 on a road in the town of Sturbridge for a distance of 500 ft. across a wooded swamp which varied from 5 to 28 ft. in depth.

After clearing and burning the trees and brush, the roots and fallen wood were loosened by a series of explosions using one-half stick of dynamite to a hole. The holes were spaced 5 ft. apart and were about 1½ ft. deep. The loosened material was then removed by pulling with a hoisting engine and dragline. A fill about 15 ft. wide was then made over the swamp surface to a sufficient depth to permit trucks to run over it, and as fast as this settled material was added in 2-ft. layers.

On both edges of this fill sticks of 75 per cent dynamite were placed at intervals of 2 ft. to a depth of 3 to 5 ft. The end charge consisted of two sticks with an exploder in the end of one. The other charges were exploded by concussion from the end charge. After this blast had been fired 1¼-in. pipes were driven to hard bottom at intervals of 6 ft. and about 10 ft. from the edge of the proposed macadam. Before being driven the ends of the pipes were hammered together to keep out the muck. One stick of ½ lb. of 60 per cent dynamite was loaded into each pipe and exploded with an electric cap to open a chamber at the bottom to permit of loading additional dynamite. Where the swamp was 5 to 10 ft. deep 8 to 15 lb., and where 20 ft. deep 25 to 35 lb. of dynamite was placed in the chambers. The road was equally loaded for both sides and the charges on both sides were exploded simultaneously.

As a result of the explosion muck was thrown into the air, but the gravel fill was not thrown out. A section

PRELIMINARY BLAST AND DRAGLINE REMOVE TOP MAT

of the fill would be raised from 2 to 5 ft., falling back into place with a final settlement of 2 to 4½ ft. and leaving cracks and openings in the center running longitudinally with the road having a depth of 4 to 10 ft. and being from 1 to 4 ft. wide. There were also cracks across the road from 1 to 3 ft. deep and from 6 in. to 1 ft. in width, though the transverse cracks were smaller than the longitudinal breaks. Fill was again brought up to subgrade about 15 ft. wide.

A steam shovel was used to excavate the muck that had been raised above the surface of the swamp by the force of the explosions and the pressure of the filling. The entire surface of the swamp adjacent to the road was raised a maximum of 6 ft. where the muck was deepest and the most fill was put in. The depth of the fill at this point, as near as it could be estimated, was about 28 ft. Trees 12 to 15 in. in diameter were raised with the muck to a height of 5 to 6 ft. The largest charge of dynamite exploded at any one time was 800 lb., all 60 per cent. It is expected the total cost of blasting this swamp will be about $2,500 and it will require about 3,500 cu.yd. of dirt to fill the hole. The road will be filled to a width of 24 ft. on top.

As an example in comparison, earlier in the season in the town of Westminster it was decided to improve the alignment of a road by flattening a curve, which put about 400 ft. of the road through a swamp. It was decided to excavate the muck to provide a stable fill to support the road. A steam shovel was used to start this excavation until a depth of 8 ft. was reached, when the shovel could no longer be used to advantage. It was replaced with a crane with a clamshell bucket and excavation was continued to a depth of about 14 ft. The hole was then backfilled with gravelly material and the road completed over it. The contract price for the peat excavation was $2 per cubic yard and about 3,913 cu.yd. was removed.

FISSURE IN FILL FROM DITCH BLASTS

FIRST FILL READY FOR BLASTING SIDE DITCHES

Where the work is so located that blasting can be done without danger to passing traffic, a considerable saving can be made and as good results obtained as by excavating.

Load Test of Large Model of Cellular Concrete Arch

Box-Section Hollow Rib Tested Under Two-Point Loading Between Rigid Abutments

By Ralph J. Fogg

Professor of Civil Engineering, Lehigh University, Bethlehem, Pa.

NO CONCRETE bridges with cellular arch rings have been built in this country within the writer's knowledge. The term cellular arch ring means one of box-like section, consisting of upper and lower flanges connected by two longitudinal side walls or webs and at intervals by transverse webs. For short spans the cellular arch ring is not practical to build, but for longer spans it can be shown to be more economical than the solid ring and makes practical the building of concrete arches of much longer span than hitherto thought feasible.

Besides effecting a saving in arch ring yardage over a solid ring, the cellular construction produces a saving in centering costs. The bottom flange is first poured, then at a later date the webs and upper flange are built; the centering therefore is not called upon to carry the entire weight of the concrete ring, since the lower flange, which has previously set up, will carry a considerable portion of it. The relative stiffness of the bottom flange and centering permits the designer to compute the proportional loading carried by each. Moreover, as the cellular construction necessitates a greater ring depth, it is more rigid and also more effective in resisting moment due to eccentric lines of pressure.

For some time E. K. Cortright, consulting engineer, and the writer have been making studies of cellular arch construction. In order to determine the behavior of this type, a large sample arch was constructed and tested last spring at the Fritz Engineering Laboratory, Lehigh University. The test was a very severe one, inasmuch

as the arch was subjected to two-point loading only, which method of loading created very high radial shears between the loading points and the skewbacks, a condition not occurring in practice. However, this manner of loading did produce very low radial shears between the loading points, which case is similar to that found in service. This meant that approximately the middle quarter of the span was under a stress condition similar to that found in practice, while the haunches were under radial shears far above those found in service. By choosing this method of testing one is able to determine the behavior of the structure under conditions ranging from no radial shear to one of extreme value. This type of loading also gave large eccentricities to the lines of pressure in the ring. The test showed that the cellular arch is very rigid and that with properly designed webs it will act as a unit. There was no tendency of the side walls to separate from the top or bottom flanges.

Test Arrangement—The test arch (Fig. 1) had a clear span of approximately 17 ft., a rise of 4 ft., a uniform width of 18 in. and a depth varying from 14 in. at the crown to 22 in. at the springing line. The transverse and radial reinforcement was slight, it consisting only of No. 10 wire straps at 6-in. intervals, which enveloped the longitudinal steel.

For ease of handling, the arch was poured on its side instead of upright. Box centers made of ¼-in. wood veneer were used to form the cells of the ring, these boxes being left in place after the concrete was poured.

During the test the arch abutments rested on twin 30-in. Bethlehem girders set on the bed of the 800,000-lb. vertical testing machine. The abutments were prevented from spreading by butting against heavy double I-beams which were arc-welded to the top flanges of the girders.

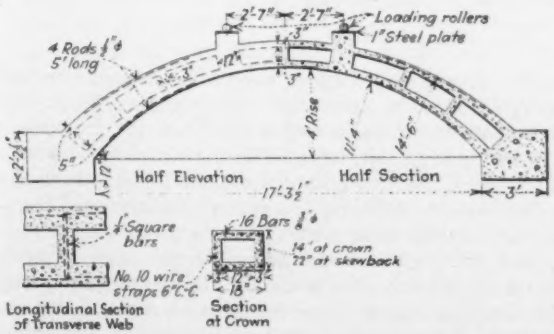


FIG. 1—TEST MODEL OF CELLULAR ARCH
Poured on side; tested under two-point loading when five weeks old; first cracks at 180,000 lb., failure at 246,000 lb.

The load from the machine was applied by a heavy girder to two rollers resting on concrete pedestals built on the arch 31 in. either side of the crown.

Test cylinders made at the time of pouring and broken on the day of the test showed an average crushing strength of 4,500 lb. per sq.in. and a modulus of elasticity of about 2,000,000. The mix was 1:1½:2½, using Delaware River sand and a well-graded gravel running to about ½-in. maximum. The arch was five weeks old when tested.

Vertical deflections were recorded at a number of points along the span, and extensometer points for 8-in. gages were located in groups on both sides of the arch for the measurement of compressive stresses.

Results—Under a loading of 180,000 lb. fine diagonal tension cracks developed simultaneously on each side wall just outside the loading points. At about the same time a fine horizontal crack developed on the top of the ring about 12 in. from each skewback. Another fine crack developed on the top at one end of the span only, about 18 in. above the lowest transverse web. The arch continued to carry load up to 246,000 lb., when failure occurred at points near or along the first tension cracks.

It is interesting to note that the arch ring carried nearly 60 times its own weight under very unfavorable loading. The failure was caused by a heavy concentration on the thin model, coupled with heavy radial shears produced just outside of the loading points. These heavy local stresses and excessive radial shears would not occur on a full-size arch, especially where loading is applied at intervals along the arch instead of at two points only.

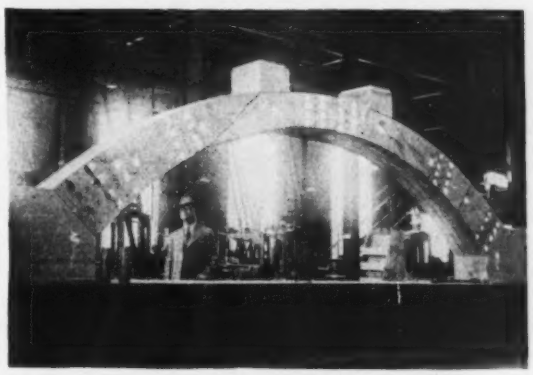


FIG. 2—ARCH AFTER FAILURE
Fractures exaggerated by running machine after maximum load was passed.

The computed compressive stresses were in all cases higher than those indicated by the extensometer measurements. Under 180,000 lb. the compression ranged from 1,000 to 1,700 lb. per sq.in. near the crown and from 1,100 to 1,900 lb. per sq.in. in the haunches. The maximum web stress due to shear, just before the first sign of crack at the 180,000-lb. loading, was estimated to be about 500 lb. per sq.in. The deflection at the crown under the same loading was ¼ in.

Production of Electricity Increases 10 Per Cent in 1928

There was an increase of 10 per cent in the kilowatt-hours of electricity produced by public utility power plants in 1928, as compared with 1927. The kilowatt-hours produced by these plants amounted to 87,851,000,000. Of this amount about 40 per cent was produced by the use of water power. This is the largest water-power ratio ever reached and is an indication that the use of water power is maintaining its position in competition with power produced by the use of fuels. The public utility companies continued the improvement in efficiency in the use of fuels in generating electricity which has been under way for a number of years. This was made possible by lowering the average rate of fuel consumption in generating a kilowatt-hour of electricity from 1.84 lb. in 1927 to 1.76 lb. in 1928. This seemingly insignificant decrease of about 1¼ oz. of coal in generating a kilowatt-hour of electricity conserved the total of more than 2,000,000 tons of coal in 1928, representing a saving of about $8,000,000. These figures are taken from a report to the U. S. Department of the Interior.

Engine Terminal and Shops, Texas & Pacific Ry.

Fort Worth Yard Has Mechanical Plants for Washing Engines and Boilers and Getting Up Steam—Steel Repair Shop of Transverse Type—Fuel-Oil Supply for Engines

ENGINE terminal facilities, including modern equipment and labor-saving apparatus and a shop plant equipped for heavy repair work on both locomotives and freight cars, form important features in the new Lancaster freight yard of the Texas & Pacific Railway, at Fort Worth, Tex., described in *Engineering News-Record* of Jan. 10, 1929, p. 63. A portion of this large terminal is shown in Fig. 1.

Engine Terminal—All the engine terminal facilities are located at the eastern end of the freight yard, in the space between the main tracks, which are spread at this point so as to pass outside of the yard. All engines enter and leave this terminal at its eastern end, as indicated by the track plan, Fig. 2. The general layout of engine terminal and shops is shown in Fig. 3.

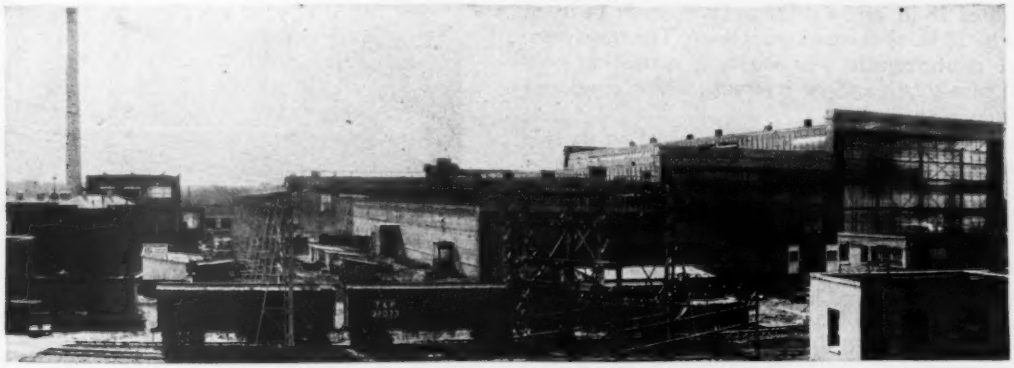


FIG. 1—ROUNDHOUSE AND SHOP AT FORT WORTH, TEX.
Material yard with crane runway in center, between engine house on the left and locomotive repair shop at the right. View looking south.

Incoming locomotives from trains in the two groups of receiving tracks at the west end of the yard layout are run over thoroughfare tracks to reach the east entrance to the engine terminal, where two lead tracks run direct to the engine house. Parallel with these lead tracks are two additional tracks, so that there is room for eighteen incoming engines waiting for terminal service. Outgoing engines leave the lead tracks at a point near the turntable and pass to two outbound tracks serving six dispatching tracks on which twelve engines can be held ready to be moved to the departure tracks to take outbound trains. This track layout is arranged to provide for free movement without interference between incoming and outgoing engines.

On the two inbound lead tracks, and beyond the storage tracks, are concrete platforms on which engines are washed and cleaned by a cleaner system. Beyond these are the concrete inspection pits, where the engines are examined for repairs. As oil fuel is used by all the engines of this railroad, there is no ashpit or coaling station, although the inbound leads are long enough to install these facilities in advance of the turntable, should it be necessary in the future. The two leads converge to a twin-span electrically operated turntable 105 ft. long.

Standpipes or columns for delivering water and fuel oil are located on the two inbound and two outbound tracks. Near them are hoppers supplied with sand from a drying plant, to be spouted into the engine sandboxes. Water is pumped from the Clear Fork of the Trinity River to a 300,000-gal. elevated tank. Fuel oil is discharged from tank cars into sumps on a spur track, from which it flows to a 12,000-gal. underground sump. Thence it is pumped directly to two steel storage tanks above ground, with a combined capacity of 861,000 gal. From these tanks the oil flows to the standpipes alongside the engine tracks.

Engine House—The roundhouse (Fig. 4), with 32 stalls and provision for extension to include 55 stalls, is of timber frame construction, except for concrete columns and girders in the outer wall. Its inner wall, 81 ft. from the turntable pit, has a radius of 133.75 ft. Its width is 120 ft., in five 24-ft. bays. The two inner bays, housing the tenders, are 18 to 20 ft. high, while the others have a clear height of 28½ to 25½ ft. from rail to roof beams. In view of the mild winter climate there are no doors to close the track openings facing the turntable. Ventilation is aided by louvers in the face of the high bay, while the windows which form the greater part of the rear wall have pivoted panels at the top and vertically sliding panels at the bottom. Wood sash is used here on account of its resistance to the action of smoke and gases.

The structural frame consists of 12x12-in. posts on concrete pedestal footings, carrying 12x12-in. ring girders, on which are radial rafters covered with 2x8-in. shiplap plank and asbestos roofing. There are no skylights. All timber is untreated yellow pine, not painted. Each bay or stall is 14 ft. wide c. to c. at the inner side and 26 ft. 6¾ in. at the outer side.

The engine pits are 95 ft. long and there are two drop-pit tables, with detachable bridge tops, for removing and replacing truck and driving wheels. The transverse

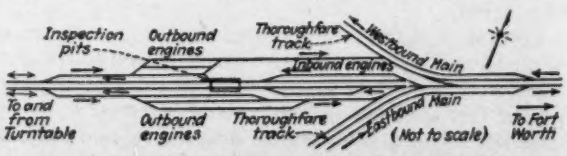


FIG. 2—TRACK LAYOUT AT YARD ENTRANCE

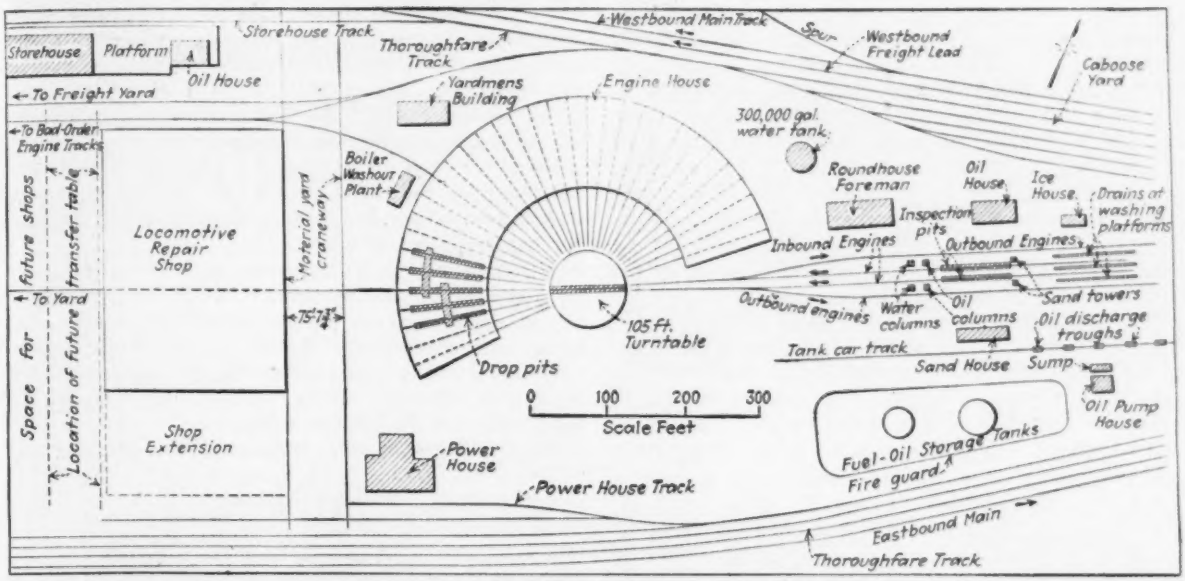


FIG. 3—PLAN OF ENGINE TERMINAL AND SHOPS

openings between the engine pits are covered by wood panels when not in use. Each drop pit serves three tracks, but they overlap so that one of the tracks is served by both pits. An electrically operated truck with motor-driven wheel hoist travels in each drop pit. Track rails are not anchored to the concrete walls of the engine pits, but are laid on tie-plates on 6x8-in. ties, 30 in. long, space 2 ft. c. to c., embedded in the concrete. Outside of each rail are two lines of 6x12-in. oak timbers, for convenience in jacking, but the remainder of the round-house floor is a 6-in. reinforced-concrete slab, suitably crowned for drainage.

Rapid washing and filling of the engine boilers are effected by a direct steaming system. The boiler is blown out through a pipe connection to a tank, and is refilled with hot water from another tank and live steam from high-pressure stationary boilers in an adjacent power house. The water is shut off when it reaches a proper level in the boiler, but live steam is admitted until a working pressure is reached, permitting the engine to be run to the outbound track before the fire is lighted. This method frees the roundhouse from the objectionable smoke and gas resulting from lighting fires under cold engines in the house. About 75 engines are handled and cleaned at this terminal daily, half of them requiring their boilers to be washed out and refilled.

Adjacent to the engine house is a brick building, 88x40 ft., with office for the roundhouse foreman and wash and locker rooms for engine crews. There are also a brick oilhouse, 50x30-ft., an icehouse, and other facilities for sheltering and distributing supplies for the locomotives.

Engine Repair Shop—Behind the engine house is a steel-frame repair shop, 240x340 ft., with nine repair pits, 60 ft. long, but space is provided for ultimately extending its length to 480 ft., with space for twenty pits. It is of the transverse type and is approached by a track passing through the engine house from the turntable. This track continues through the shop to the bad-order engine tracks and to a west connection with the yard. Engines are moved to and from the repair tracks in the erecting shop by a 250-ton overhead traveling crane. Ground space is left for a future boiler and tank shop and also for a future transfer table between this and the present shop. The big crane has two 125-ton hoisting trolleys, each with a 15-ton auxiliary hoist. Below it are two 15-ton messenger cranes. Engines for repairs enter at the west side, which is the erecting shop. They are backed in so that the smokeboxes face the doors, for convenience in removing boiler tubes.

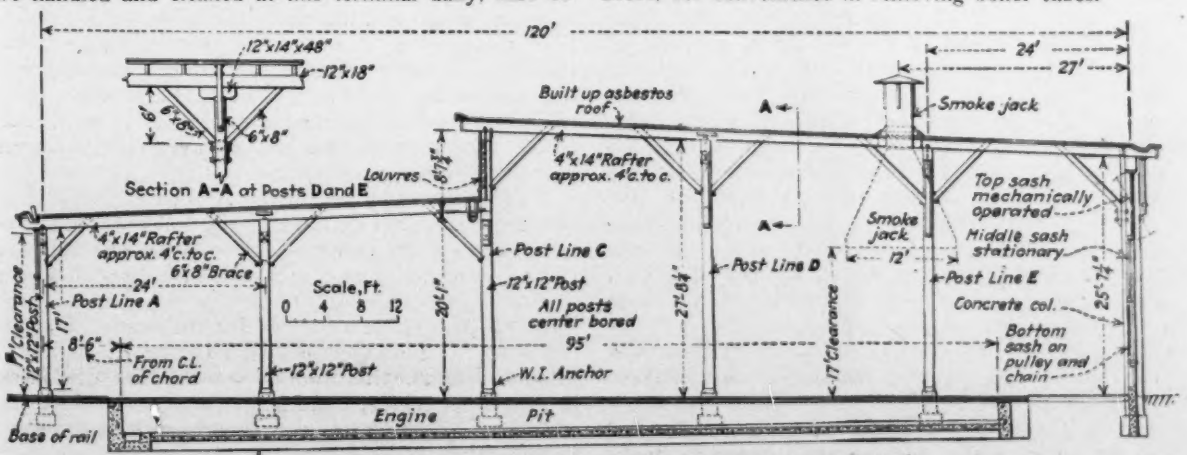


FIG. 4—ENGINE HOUSE CONSTRUCTION, TEXAS & PACIFIC RAILWAY

It will be seen by Fig. 5 that the main floor of the shop has four bays, divided only by the columns: Erecting shop, 90 ft. c. to c.; heavy machine shop, 80 ft., with a 15-ton traveling crane; light machine shop, 50 ft., and then a 20-ft. bay for tools and storage. Above this last is a second floor containing toilet, wash and locker rooms. In the heavy machine shop every third bay has the roof carried by the bottom chords of the trusses, so as to form a series of transverse monitors. Over the light machine shop is a large longitudinal monitor. The shop floor is paved with 3-in. creosoted wood blocks on a tar cushion on 6-in. concrete base.

Built-up columns of the erecting shop are of T-section up to the runway girders of the 250-ton crane, as shown. A transverse web plate has two flange angles on the outer end and two connection angles for a web plate having a channel at each end, as shown. Attached to the longitudinal web plate is a 12-in. I-beam supporting the runway girder for the lighter cranes. Above the large crane the column is of I-section, with a web plate and four flange angles. In the other shops the columns are H-beams. The walls are almost entirely of steel sash with wire glass. For the runway girders of the 250-ton crane, those of 31-ft. span are composed of a web plate, 60x$\frac{3}{4}$ in., with flange angles, 8x8x$\frac{3}{4}$ in., and a top cover plate having each stiffened by an angle 8x6x$\frac{3}{4}$ in., on which is the 150-lb. crane rail. The bottom chord has one $\frac{3}{4}$-in. and two $\frac{1}{2}$-in. cover plates, all 18 in. wide and the full length of the girder. In the 24-ft. spans the web is the same, but the angles and cover plates are lighter. For the 15-ton cranes the runway girders have a web plate, 36x$\frac{3}{8}$ in., with four flange angles, 6x6x$\frac{3}{4}$ in., and an inverted 15-in. channel for the top chord, carrying the 60-lb. rail.

Each 24-ft. bay of the erecting shop has steel track doors, so that no alterations will be necessary when a transfer table is installed along the front of the building. Between the shop and the engine house is a space 500x75 ft. allotted to storage of heavy materials. This is served by an overhead 15-ton traveling crane which extends the full length of the storage space and over adjacent tracks to provide for loading and unloading cars.

Car Repairs—Light repairs to freight cars are done on a group of four tracks, holding 58 cars, near the switching hump. Cars needing heavy repairs are moved to the repair yard adjacent to the shops. In both these repair yards the tracks are in pairs, spaced alternately 16 and 24 ft. c. to c. Piping for compressed air is provided for testing brakes and operating pneumatic tools.

In the main car-repair yard, a steel-frame shed, 300x80 ft., is provided for doing heavy repairs under shelter, especially work on steel cars. Each 40-ft. bay has two tracks spaced 22 ft. c. to c., the four tracks giving a total capacity for about 24 cars. On account of the warm climate, the ends and lower part of the sides of the shed are left open. Adjacent to this yard are buildings for the wood-working machinery, metal-working machinery, forges and other equipment required for freight-car repair work.

Miscellaneous Shop Facilities—At present practically all activities of the mechanical work for locomotive repairs are housed in the one large shop building, but space west of this is reserved for future tank, tube, forge, blacksmith and other shops when increased capacity is required. These buildings would be beyond the location for the transfer table.

A power house supplies steam at 250-lb. pressure and compressed air for the plant, while the pumps, tanks and other equipment for washing out and refilling the locomotives are housed in a separate building. Electric current for light and power is furnished by the local electric company. A two-story concrete and brick storehouse, 55x200 ft., is served by a stub track and has an open platform, 55x100 ft., at each end. There is also a brick and concrete oil house, 53x35 ft., with basement. As the mechanical department offices are on the upper floor of the storehouse building, a 1-in. layer of insulating material is provided in the roof to minimize the effect of the hot sun. Concrete roads serve the shop plant to facilitate the distribution of material by motor trucks and tractors with trailers.

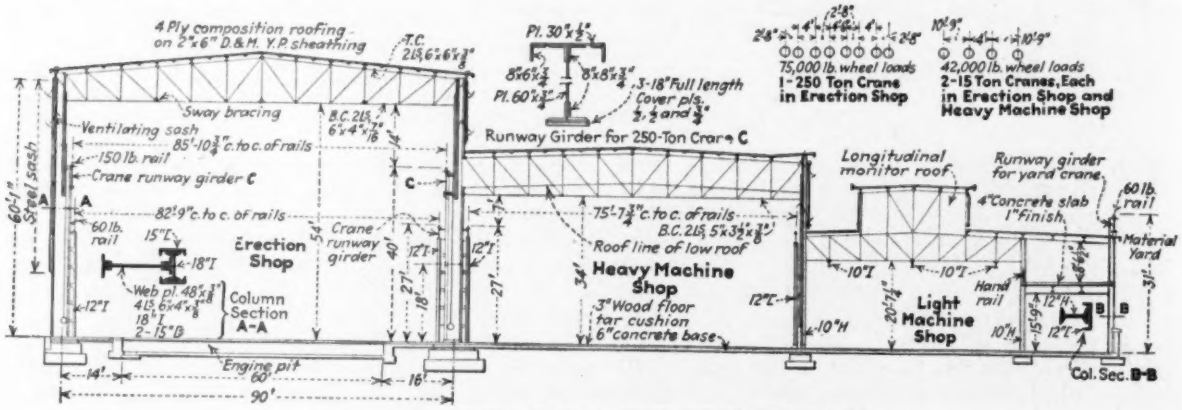


FIG. 5—LOCOMOTIVE REPAIR SHOP, FORT WORTH, TEX.

Engineers and Contractors—The Lancaster yard, including its engine terminal and shops, was designed and built under the direction of E. F. Mitchell, chief engineer, Texas & Pacific Railway, and his staff, with F. R. Nayler as resident assistant engineer in direct charge of construction.

Grading was done by the D. A. Foley Construction Company, Los Angeles, Calif. The boiler-washing system is that of the National Boiler Washing Company, Chicago, which concern also installed the direct-steaming system of the Railway Engineering Equipment Company, Chicago. The buildings for the engine terminal and shops were detailed and built by the Austin Company, Cleveland, Ohio, under the direction of Harry E. Stitt, chief engineer, and R. C. Farrington, equipment engineer. All tracklaying was done by railway company forces.

Two New Sewage Grit Removal and Washing Installations

Revolving Scrapers Push Deposit in Grit Chambers to Long Washing Channel Equipped With Reciprocating Rakes

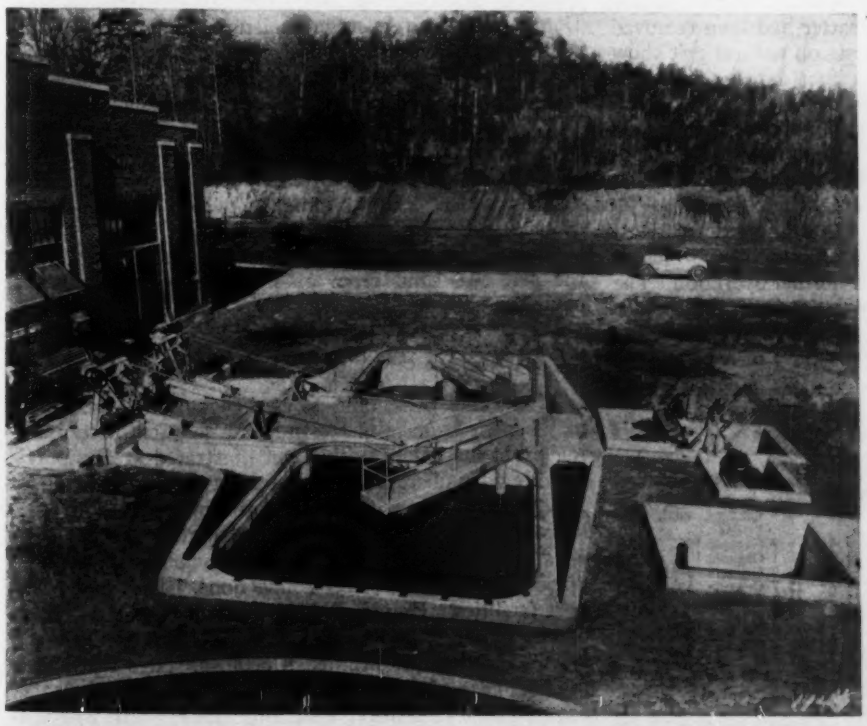
AUTOMATIC apparatus for gathering, lifting, washing and removing deposits in the grit chambers of sewage-works is now in use at Harrison, N. Y., and Winston-Salem, N. C. The combination is known as Detritor (a copyrighted word covering a mechanically cleaned grit chamber). The installation at Harrison was the first permanent one to be put in use. It has been in operation since Aug. 29, 1927. The Winston-Salem Detritor went into service Dec. 10, 1928. Other installations are now in progress at Aurora, Ill.; Scarboro, Ont.; Topeka, Kan., and Dunkirk, N. Y. This article relates chiefly to the Harrison installation, including operating tests made there, but concludes with a short account of the Winston-Salem installation.

The sewage-treatment plant of Harrison originally consisted of a bar screen, a Dorrco screen, two Imhoff tanks and sprinkling filters followed by humus tanks. The sewer system is of the separate type. During storms, however, the normal dry-weather flow of 0.5 to 0.6 m.g.d. is largely increased, sometimes up to 6 m.g.d., and large amounts of grit are flushed into the treatment plant through the old sewers. This caused so much difficulty that it was necessary to consider some method of grit removal. This grit collected in the lower compartments of the Imhoff tanks and plugged up the sludge discharge piping to such an extent that it became almost impossible to drain the digested sludge to the drying beds. Furthermore, the grit in the Imhoff tanks occupied valuable space which was acutely needed for biological work in view of the fact that these tanks were handling much more than their designed capacity. In one instance 35 cu.ft. of grit was removed in the cleaning of one tank.

DISCHARGE END OF DETRITOR AT WINSTON-SALEM SHOWING PILE OF WASHED GRIT

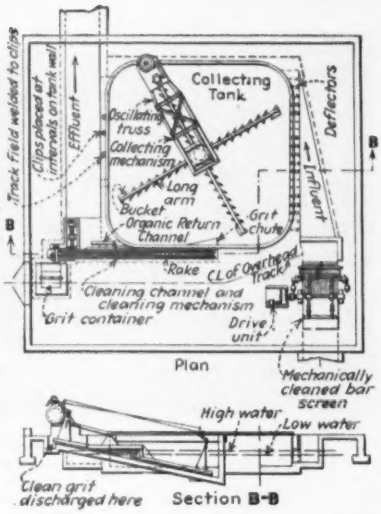
At Harrison the Detritor consists of a concrete grit-collecting tank 10 ft. square and 1 ft. deep, equipped with a grit-collecting mechanism; a concrete grit-washing channel 1¼ ft. wide by 15 ft. long, provided with reciprocating rakes to push the grit to the outlets and clean it on its way; and a 1-hp. electric motor to drive the gatherer and a 2-hp. motor for the rakes.

Guide vanes along the inlet side of the grit chamber direct the sewage flow across the tank in straight lines. Along the outlet side there is an adjustable weir, over which the degritted sewage flows to further treatment. Retardation of the sewage flow in this tank causes the greater part of the non-organic matter to settle upon the bottom, from which it is collected and conveyed to a discharge chute at one side by the grit-collector, which operates much as does the Dorr traction clarifier, since the oscillating truss which sweeps the corners of the tank is driven by a monorail motor car attached to the other end of the truss and running on a rail on the tank top. The grit collector differs from the clarifier in that the raking blades move the grit radially outward, into the grit chute, instead of radially inward to a central discharge opening. The collected grit is discharged by the chute into the lower end of the washing channel, which parallels the grit chamber and extends 3 ft. beyond it to allow the washed grit to drain before its final discharge. The reciprocating rakes just clear the inclined bottom of the channel. In advancing the grit along the inclined bottom to the point of discharge, the rakes impart a gentle rubbing and turning motion



DETRITOR AT SEWAGE-WORKS OF WINSTON-SALEM
Two 18-ft. detritors in center foreground each of 9-m.g.d. capacity. At right is a Dorrco mechanically cleaned bar screen.

which frees the grit of the organic matter. The latter is buoyed up in the water and flows into the collecting tank again through an opening in the dividing wall. Tests were made at Harrison to determine the minimum size of grit recoverable under normal conditions, with regard to the effect of the grit on the equipment, and also the degree to which putrescible organic matter could be removed in the cleaning compartment. The percentage of organic solids in the washed grit is the factor governing the effectiveness of washing. The term "organic solids" when first considered might be taken as meaning all material that can be removed by ignition. The ignition method of determining organic matter in the recovered grit might well be misleading at times, because many materials of an organic but not putrescible nature find their way into the sewers, such as coal dust, fruit seeds and grain. The only organic solids which are objectionable in the recovered grit are those which will change in character on standing exposed to the atmosphere, creating objectionable odors and rendering the grit unfit for use. The amount of this putrescible organic matter was determined (see table) by ignition of the sample after all coal, seeds and similar matter had been removed by hand picking. All of these tests on natural grit show putrescible organic contents less than 5 per cent. The average of all four is 2.23 per cent.



PLAN AND SECTION OF DETRITOR

These results are believed to be highly satisfactory, as 10 per cent putrescible organic matter is usually recognized by sanitary engineers as allowable without creating a nuisance.

In June, 1928, the Detritor was subjected to a test which was much more severe than anything which it would be called upon to handle in normal operation. The humus tanks, which receive the effluent from the sprinkling filters, after a little more than a year's operation had become filled with a thick black pulp of a gelatinous nature, made up of sewage gel from the filters and sand and raw sewage which had been bypassed direct to the humus tanks during storms when the flow exceeded the capacity of the screen and Imhoff tanks. Each particle of sand and grit was thoroughly coated with this gelatinous organic material. To transfer this humus tank sludge to the tanks and at the same time prevent the grit entering the tanks, it was decided to run the mass through the Detritor by pumping it from the humus tanks into the sewer through a manhole upstream from the plant. Even under these exceptionally severe conditions, with a feed having a very high ratio of organic matter to grit, the washed product discharged from the Detritor contained only 12.5 per cent putrescible organic matter, which compares favorably with the best results obtained in normal grit chamber work by the old methods.

The installation of this automatic grit chamber at Harrison has effectively protected the plant equipment which follows it and has provided a convenient and effective method of re-treating the sandy sludge from the humus tanks. Operating 24 hours a day at a consumption of 1 hp., it has produced a clean grit which has been put to good use in filling depressions around the plant and has removed once and for all the disagreeable conditions which unwashed and exposed grit creates.

The Winston-Salem installation consists of two Dorr Detritors, the grit-collecting tanks being 18 ft. square and the grit-cleaning channels 1¼ ft. wide by 28 ft. long. Each unit is provided with a 1-hp. motor for the grit-collecting mechanism and a 2-hp. motor for the grit-cleaning mechanism. The Detritors have a maximum storm-flow capacity of 9 m.g.d. and are immediately preceded by a Dorrco mechanically cleaned bar screen. Over a two weeks' test period, ended Jan. 3, 1928, the average sewage flow was 4.5 m.g.d. and the daily removal of grit 1½ cu.yd. The clean grit recovered by these Detritors has an average moisture content of 15 per cent and an average total organic content (putrescible and non-petrescible) of less than 5 per cent.

Harry L. Shaner, commissioner of public works of Winston-Salem, states that the grit is used to fill low places around the plant and that the removal of grit in this manner should prolong the life of mechanical devices which follow, some of which show evidence of having been sand pitted previously. Before the installation of these Detritors it was necessary to remove the grit and sand from pits, conduits and mechanical equipment.

PERCENTAGE OF NATURAL GRIT RECOVERED BY DORR DETRITOR AT HARRISON, N. Y.

Mesh	Test No. 1 Actual	Test No. 1 Cumulative	Test No. 2 Actual	Test No. 2 Cumulative	Test No. 3 Actual	Test No. 3 Cumulative	Remarks All Samples
+ 10	14.0	14.0	5.4	5.4	3.5	3.5	Cinders, coal, pebbles
+ 14	6.2	20.2	4.7	10.1	3.4	6.9	Organic 10% (seeds)
+ 20	9.4	29.6	5.0	15.1	3.2	10.1	Organic 10% (seeds)
+ 28	14.5	44.1	7.7	22.8	4.8	14.9	Organic 5% (seeds)
+ 35	28.9	73.0	14.5	37.3	8.8	23.7	Organic 5% (seeds)
+ 48	14.8	87.8	20.1	57.4	17.3	41.0	Silica
+ 65	6.9	94.7	29.7	87.1	28.4	69.4	Silica
+100	1.4	96.1	10.1	97.2	21.2	90.6	Silica
+150	1.3	94.4	1.5	98.7	4.8	95.4	Silica
+200	....	....	0.8	99.5	3.7	99.1	Silica
+200	2.6	....	0.5	....	0.9	....	....

Percentage of putrescible organic contents: No. 1, 2.17, determined by ignition of sample after hand picking to remove non-putrescible organics; No. 2, 0.91; No. 3, 0.92. Subsequently a test was made on a composite sample of the grit recovered during a period of three weeks. After removing non-putrescible organics as before, the composite sample showed a loss on ignition of 4.9 per cent.

Regional Planning Spreads to Small Towns

That small communities, as well as the larger cities, may benefit from joint action in the solution of engineering problems has recently been illustrated at Camp Hill and New Cumberland, two towns on the west side of the Susquehanna River opposite Harrisburg, Pa. The problems which united these two communities are the usual ones which first force regional consciousness: sanitary disposal of sewage, street connections, health and transport facilities. Francis J. Mulvihill, chief of the division of city planning and municipal engineering of the Pennsylvania Bureau of Municipal Affairs, states that this is the first case of regional planning on the part of smaller communities in Pennsylvania, although regional work has already been done around Philadelphia, Pittsburgh and Washington.

Major Provisions of an Arc-Welding Specification

Adaptable to General Use—Has Been Utilized in Present Form on Six Recently Welded Buildings

By Frank P. McKibben

Consulting Engineer, General Electric Company, Schenectady, N. Y.

RECOGNITION of the possibilities for welding in the structural field is resulting annually in an increased number of buildings which utilize it either in whole or in part for major connections. As growth has continued, the need for a generally available specification has become more apparent. In fact, one of the major activities of the Structural Steel Welding Committee has been to draft a building code that would provide some sort of official guidance for those specifying welding. This code, which will cover both gas and electric welding processes, will soon be ready for publication.

The following specification as prepared by the writer is being used in almost identical form on six welded structures. It was prepared solely for use with the electric-arc process and was not intended to include oxyacetylene welding. In other words, it is a specification and not a building code.

The major provisions of this electric arc-welding specification are presented here much as they appear in the original specification except that in several cases it has seemed advisable to explain several of the provisions parenthetically for the benefit of the general reader. The major clauses of the current welding specification follow:

Definitions

Arc Welding—The process of joining steel parts in the molten or molten and vapor states, by the electric arc without the application of mechanical pressure or blows.

Arc Weld—A weld in which welding heat is generated by an electric arc formed between the base metal and the electrode, or between two electrodes, with or without the use of hydrogen or other equivalent gases.

(The expression "with or without the use of hydrogen or other equivalent gases" is inserted to permit welding by the atomic-hydrogen or hydrogen-arc process. Although neither of these methods is now applied to steel buildings, it seems wise to include a general clause which, if the processes should ever be desired for this purpose, will cover it. As it is conceivable that some gas other than hydrogen may be used, the term "equivalent gases" is inserted. In atomic-hydrogen welding, hydrogen gas is blown into an arc formed in the gap between the closely spaced ends of two tungsten electrodes; the arc dissociates the hydrogen molecule—that is, separates it into its two atoms, which upon reuniting generate an intense welding heat. Since the tungsten electrodes do not furnish any filler material, a welding rod must be held in the heated zone in the same manner as in oxyacetylene welding. The hydrogen-arc weld consists in blowing hydrogen into an ordinary arc at the same time that the melting welding wire or electrode is adding the extra metal to form the weld. Consequently in the following paragraph the definition of electrode is worded to include the electrode in an ordinary arc-weld and in a hydrogen arc-weld, in each of which the electrode melts to form the filler metal of the weld, whereas in the atomic-hydrogen process the electrodes do not melt and a filler rod must be used.)

Electrode—A specially prepared metal wire or rod used as a terminal in an electric circuit to produce an intense heat by means of the arc, and which may or may not supply the molten steel required for joining the parts to be welded.

Filler Metal—Metal which is added to a weld by the melting of an electrode or a welding rod.

Weld Metal—Material composing a weld.

Base Metal—Material to be welded.

Fillet Weld—A weld, at the intersection of two surfaces approximately at right angles to each other, in which the weld metal has an isosceles triangular cross-section, its two sides being fused with the original surfaces of the base metals, and its third side being exposed. The size of a fillet weld is expressed in terms of its length and width, the length being the effective length exclusive of crater, the width being the length of the side of the largest isosceles triangle contained in the cross-section of the weld metal.

Butt Weld—A weld joining the edges of a butt joint in which two members are brought together edge to edge but not necessarily in contact, one surface of each member being in the same or parallel planes.

Continuous Weld—A weld of unbroken continuity used for strength or tightness or both.

Intermittent Weld—A strength weld consisting of a series of short welds in line, alternating with unwelded spaces.

Tack Weld—A short weld used for purposes of assembling only.

Quality of Materials

Structural Steel—Steel used in structures covered by these specifications shall be of the grade designated as "Structural Steel for Buildings" as specified by A.S.T.M. Serial No. A9 as amended to date.

Electrodes and Welding Rods—Wire used for electrodes or welding rods shall be commercial mild steel wire made for this purpose, of uniform homogeneous physical structure; free from irregularities in surface, from hardness, segregation, foreign matter, oxides, pipes, seams or other defects.

Diameter shall not vary more than 0.003 in. above or below nominal values.

In the hands of an experienced welder, electrodes and welding rods shall show good welding qualities in flat, vertical and overhead positions, and shall pass through the welding process without any unusual characteristics.

Chemical compositions shall conform to the following limits for uses specified:

	Wire Grade A (Hand Welding)	Wire Grade B (Automatic Machine Welding)
Carbon	0.13 to 0.18 %	Not over 0.10 %
Manganese	0.40 to 0.60 %	0.25 to 0.45 %
Phosphorus	Not over 0.045%	Not over 0.045%
Sulphur	Not over 0.045%	Not over 0.045%
Silicon	Not over 0.06 %	Trace

(The above provision is intended to cover only the ordinary bare metallic electrodes of low-carbon steel. No coating of flux material on the electrodes is needed for hand arc-welding structural or cast steel, although it is true that for certain kinds of welding lying beyond the field of these specifications electrodes covered with a fluxing material are often used.)

Apparatus

Welding current shall preferably be direct current supplied by generators driven by electric motors or engines having suitable automatic speed regulation. Whether for use in hand or machine welding, generators shall be adjustable for different current values and shall deliver constant current at suitable voltage for each setting of the regulator.

Permissible Unit Stresses

1. Welded joints shall be proportioned so that combined dead and live loads, and impact, if any, shall not cause the stresses therein to exceed the following amounts in pounds per square inch:

Shear on minimum section of weld metal	11,300
Tension on minimum section of weld metal	13,000
Compression on minimum section of weld metal	15,000

Maximum fiber stresses due to bending shall not exceed the values prescribed above for tension and compression respectively.

(*A Design Example*—In Fig. 1 are shown two plates connected by ⅜-in. fillet welds. The longitudinal shearing value on the line *X*, minimum section of fillet, at a safe unit stress of 11,300 lb. per sq.in., is 0.266 × 11,300 = 3,000 lb. per linear inch. Hence, required number of linear inches to transmit 42,000 lb. from *B* to *A* is 42,000/3,000 = 14; or 7 in. on each side of Plate *B*. The minimum dimension of fillet *X* is called the throat. In the accompanying table are given longitudinal shearing values for fillets of various sizes based on a safe unit shearing stress of

FIG. 1—TWO PLATES CONNECTED BY ⅜-IN. FILLETS

11,300 lb. per sq.in. Taking a ¾-in. fillet as the starting point, it is observed that since a ½-in. fillet is four-thirds as large as a ¾-in. fillet, the longitudinal shearing value for the ½-in. fillet is four-thirds of 3,000, or 4,000 lb., as shown in the table. Similarly, for a ¼-in. fillet, two-thirds of 3,000, or 2,000 lb. In other words, for each increase of ¼-in. in the side of the fillet, the working unit stress increases 1,000 lb.)

2. Stresses in welded joints due to wind only, and combined stresses due to wind and other loadings, may exceed by 33⅓ per cent the values prescribed in the table; provided, the section thus obtained is not less than that obtained if the wind force be neglected.

3. In designing welded connections allowance shall be made for bending stresses due to eccentricity, if any, except that in designing fillet welds no allowance need be made for the bending couple formed by resultant stresses on the two fused sides of the weld.

Workmanship

1. Surfaces to be welded shall be reasonably cleaned, by wire brushing, chipping or hammering, of loose scale, rust, paint or other foreign matter; except that a thin coat of linseed oil need not be removed before welding.

2. Welding operators shall submit evidence of experience in welding structural steel with the kind of welding to be used on the proposed work, and show ability to make flat, vertical and overhead welds of uniform quality conforming to requirements of these specifications.

3. After being deposited, welds shall be brushed with wire brushes, and shall show uniform section, smoothness of weld metal, feather edges without overlaps, freedom from porosity and clinkers. Visual inspection at edges and ends of fillets and butt joint welds shall indicate good fusion with and penetration into base metals.

4. Arcs for electric welding shall be of proper lengths to produce good welds.

(In welding structural steel with $\frac{5}{32}$-in. electrodes, current of 175 to 200 amp., and arc voltage of 20 to 22, the length of arc should be from $\frac{1}{8}$ to $\frac{5}{32}$ in.; for ¼-in. electrodes, 250 amp. or more and arc voltage of 18 to 26, the length of arc will be from $\frac{5}{32}$ to ¼ in. With $\frac{5}{32}$-in. electrodes, 40 amp., and 15 to 18 voltage, the arc length will be about $\frac{5}{32}$ in. When low-carbon steel electrodes like those specified are used, the short arc makes a crackling sound, whereas an arc too long gives a hissing sound interrupted by sharp explosions which scatter globular metal particles about the fillet.)

5. The following figures for current values are approximations only, intended as a guide to the operator who shall select the size of electrode and adjust the current to produce good homogeneous welds of above characteristics:

Electrode Diameter, In.	Amperes Hand Welding	Corresponding Plate Thickness, In.
$\frac{5}{32}$	50– 75	Up to $\frac{5}{16}$
$\frac{3}{16}$	75–100	Up to ½
¼	100–150	½ up
$\frac{5}{16}$	150–200	½ up
$\frac{3}{8}$	175–225	½ up
½	200–250	½ up

The same electrode may be used with various thicknesses of plate, but thicker plates require heavier currents.

6. Current values for machine welding may exceed those specified above for hand welding, but machine welding shall if required meet qualifications for welders hereinafter specified.

SAFE WORKING STRESSES OF TRIANGULAR FILLETS
(Based on 11,300 lb. per sq.in. shear on throat)

Size of Fillet, In.	Longitudinal Shearing, Lb. Linear Inch.	Size of Fillet, In.	Longitudinal Shearing, Lb. Linear Inch.
¼	4,000	$\frac{5}{16}$	2,500
$\frac{3}{16}$	3,500	½	2,000
⅜	3,000		

7. In assembling and during welding the component parts of a built-up member shall be held by sufficient clamps or other adequate means to keep parts straight and in close contact.

8. In welding, precautions shall be taken to minimize "locked-up" stresses and distortion due to heat.

(By "locked-up" stresses are meant those due to expansion or contraction.)

Qualifications of Welders

Butt Welds—Welders may be required to weld four sample butt joints each made of two pieces ½x9x12 in. to form a piece about 12x18 in., prepared with double-vee described hereinafter; of these, two sample plates are to be welded in the horizontal or flat position and two in the vertical position with the joint located vertically.

Each sample plate shall be machined so that the joint is reduced to the thickness of the base metal. From each sample plate standard 2-in. tensile test specimens shall be made and tested in tension. The average tensile strength of each group of two sample plates shall not be less than 45,000 lb. per sq.in., and the tensile strength of the lowest in each group shall not be less than 40,000 lb. per sq.in.

Lap Welds—Welders may be required to weld four sample lap joints each made of ½x6x8-in. plates clamped one on the other with the 8-in. edges lined up but with the 6-in. edges offset ½ in. A full ½-in. fillet is then to be made along one 6-in. edge in accordance with specifications hereinafter described for lap joints.

Upon completion of the welds and after cooling, the specimens shall be torn apart and broken by wedging at the unwelded 6-in. edges; and the fractured metal of specimens broken through the weld shall reasonably show bright, dense, even textured, crystalline or fibrous weld metal, irregularly torn and void of iridescent colors; good fusion of weld and base metals; good penetration into right angle corner of the fillet.

Fillet Welds—Welders may be required to weld three sample test specimens of size shown in Fig. 2, each specimen consisting of two main plates 4x1x12 in. placed in line with their inner ends separated by ½ in., making the over-all length 24½ in. These plates are to be connected by two splice plates, each 3x¼x6½ in. long, symmetrically clamped to the main plates, one above and the other below the two main plates and each welded in a flat position to each main plate by two 2½x⅜-in. triangular fillets with their craters filled; each of these fillets is to be started at outer ends of the 3x¼x6½-in. splice plates and continue 2½ in. along the 6½-in. dimension toward the center, thus leaving a 1½-in. space between the inner ends of the fillets; the specimen is then to be inverted and the four remaining fillets deposited also in flat position.

In depositing the weld metal, craters shall be filled to cross-section of fillets. Electrodes of $\frac{5}{32}$-in. diameter shall be

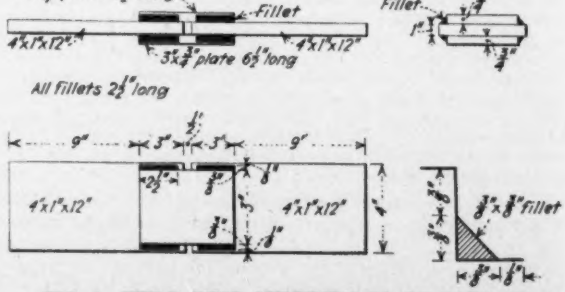


FIG. 2—WELD TEST SPECIMEN TO BE USED IN EXAMINING WELDING OPERATORS

used. These specimens are to be tested in tension to ascertain the longitudinal shearing value of the ⅜-in. fillet welds; and the fractured specimens shall be examined for penetration into and fusion with base metals, freedom from gas holes or slag inclusions in fillets. The three specimens shall show at least an average ultimate longitudinal stress of 44,000 lb. per sq.in. and the lowest in the group shall show at least 38,000 lb. per sq.in. of minimum section of fillet.

(The longitudinal shearing strength of fillet welds is the best test thus far devised. The units 44,000 and 38,000 ultimate shearing strength per square inch for the fillet, based on the throat (minimum) section, will probably be criticised as being too low, but at present these values seem sufficient in a specification of this kind.)

Proportion of Parts

Plate Girders—Girders shall preferably be proportioned by their moments of inertia, but where the approximate method of flange design is used the web equivalent may be taken as one-sixth the web area, provided no holes exist in the web.

Web splices shall consist of a plate on each side of the web.

Stiffeners may be angles or flat bars, welded to the top and bottom flanges and also to the web by continuous or intermittent welds designed to transmit the stresses. Stiffeners at bearings or other points of concentrated loading shall be fitted to the flanges.

Connection of component parts of girder flanges to each other and of flanges to webs shall be by continuous or intermittent fillet welds designed to transmit the stresses. Intermittent welds shall be not less than 2 in. long, exclusive of crater, spaced in the clear not exceeding sixteen times the thickness of thinnest piece connected, nor more than 4 in. in the clear.

Plug or slot welds may be used to fasten cover plates to each other and to other members.

Beams—Continuous beams and girders designed in accordance with generally accepted engineering principles may be used, provided that welded connections be properly proportioned to resist bending moments to which they are subjected.

Welded joints supporting non-continuous beams shall be designed with due regard for secondary bending stresses induced by deflection of the beams.

When the toe of a seat angle supporting a beam is to be welded to a web or to a column and is not truly formed, but is rounded due to worn rolls or other causes, either a preliminary fillet shall be deposited to fill the open space, after which the full fillet required in the design shall be deposited, or the rounded edge of the toe shall be sheared square to receive the full fillet required.

Trusses—In tension members connected by fillet welds the gross cross-sectional area shall be considered as resisting the stresses.

For tension or compression members having symmetrical cross-sections the fillets shall either be arranged symmetrically about the axis of the member or else proper allowance shall be made for unsymmetrical distribution.

For members of unsymmetrical cross-section, as angles, for example, lengths of fillets shall be determined by taking moments about the gravity axis of the member.

Columns—Built-up or rolled-steel columns shall contain no material except filler plates, whether in the body of the column or used as lattice bars or stay plates, less than ¼ in. in thickness.

Ends of columns shall be faced to plane surfaces at right angles to their axes. Column splices, whenever practicable, shall consist of splice plates connected to the columns with proper amounts of fillets, and if filler plates are required, they shall be connected with proper amounts of fillets. When sections of columns to be spliced are such that splice plates cannot be used, connections may be formed of plates and angles or other shapes designed to distribute the stresses properly. In all cases column splices shall be so arranged that by bolts or otherwise the various tiers of a column can be accurately aligned before welding and shall be of sufficient strength to carry erection stresses.

Fillets connecting component parts of a built-up column shall be either continuous throughout the length of the column or intermittent, arranged as follows: continuous fillets extending at each end of the column for a distance equal to the least width of column; then intermittent fillets 2 in. long spaced not exceeding 4 in. in the clear for the remainder of the column's length.

Lattice bars and tie-plates, where used, shall be welded with fillets to secure strengths equal to those of the rivets in lattice bars and tie-plates connected by rivets as specified in Standard Specifications for Structural Steel for Buildings adopted by the American Institute of Steel Construction.

Welding and Bolting—Connections of main members carrying live loads producing impact, and connections of members subject to alternate stresses, shall be welded.

For welded structures component parts of all columns, girders and trusses shall be welded with fillet welds.

For welded buildings over four stories high all column splices, and all connections of beams and girders to columns, or within 3 ft. thereof, shall be welded.

Unfinished bolts may be used in the shop or field for connections of small structures used for shelters and for connections of secondary members of all structures, such as purlins, girts, door and window framing, lining-up bracing and filling-in beams in floors. In buildings two or more stories high, sufficient bolts shall be used to connect properly all members during erection.

So far as possible all joints shall be designed to eliminate overhead welding, and arranged so that the welds will be in shear or direct compression.

Tension butt welds shall not be used in main truss members, but may be used in secondary members, wind-bracing connections, beam and girder connections.

To the calculated lengths of each weld, ½ in. shall be added to allow for the crater.

Fillet welds of lengths less than four times their width shall not be figured as part of any connection.

6. *Butt Joints*—The edges of base metal of members ¼ in. or more in thickness, transmitting stress by means of butt joints, shall be beveled with either single-vee joints or double-vee, or their equivalent.

Steel for single-vee shall be beveled not less than 30 deg. on each edge to form an open angle of not less than 60 deg., and the joint shall be backed up in an approved manner.

Steel for double-vee joints shall be beveled not less than 37½ deg. on each side of each piece.

In all single-vee and double-vee butt joints the beveled edges shall have initial free distances of ⅛ to 7/16 in. and steel ¼ to 7/16 in. thick shall be welded in one layer, steel ½ in. to ⅝ in. in two layers, and ¾ in. to 1 in. in three layers.

All above joints shall be somewhat reinforced but not to exceed 20 per cent for single-vee or 15 per cent for each side of double-vee joints.

7. *Lap Joints*—All lap joints in ¼- to 7/16-in. steel shall be fillet welded in one layer, ½- to ⅝-in. in two layers, and ¾- to 1-in. in three layers. The contour of the cross-section of the fillet shall be as near as practicable to a triangle with equal sides, and with minimum side not less than the prescribed dimension of cross-section of fillet.

8. Weld metal deposited in two or more layers shall have each layer brushed with a wire brush or otherwise cleaned before subsequent layers are deposited.

9. *Drawings*—Drawings shall show clearly all welds for shop and field welding.

(This paragraph is intended to secure on the drawings complete data on all welds. It has been, and probably is now, the practice of some welding shops to simply mark "weld"; others designate each fillet weld by its length and dimension, as weld 7 in. x ⅜ in., or 7 in. W or 7 W where a ⅜-in. triangular fillet shop weld 7 in. long is required; and 7 FW where the weld is to be made in the field. For a building of any appreciable size shop welds should be shown on the detail drawings for the shop, and all field welds should be clearly shown on separate sheets for use by the erectors in the field.)

Protection of Steel

Structural steel before being welded shall not be painted. If it is to be welded only in the fabricating shop and subsequently erected by bolts or rivets, it shall receive in the shop one coat of acceptable metal protection after shop welding is finished, and one coat after erection. Steel to be field welded shall receive one coat of linseed oil after shop welding is completed; and after being erected and welded it shall receive two coats of acceptable metal protection.

Design and Practical Test of Integrating Flume Meter

Elements of Design Developed by Formula—Meter and Register Built, Then Tested in Field Against Weir

By J. W. Ledoux
Consulting Engineer, Philadelphia, Pa.

A METHOD was developed by the writer in 1924 for measuring the discharge through flumes by means of a function of the depth in the flume, and experiments were made with flumes of different shapes—rectangular, trapezoidal and circular. It was found that a very close approximation to the actual flow could be obtained by the application of a general equation, in the form

$$Q = cH^n \qquad (1)$$

in which Q is the flow through the flume; H is the depth,

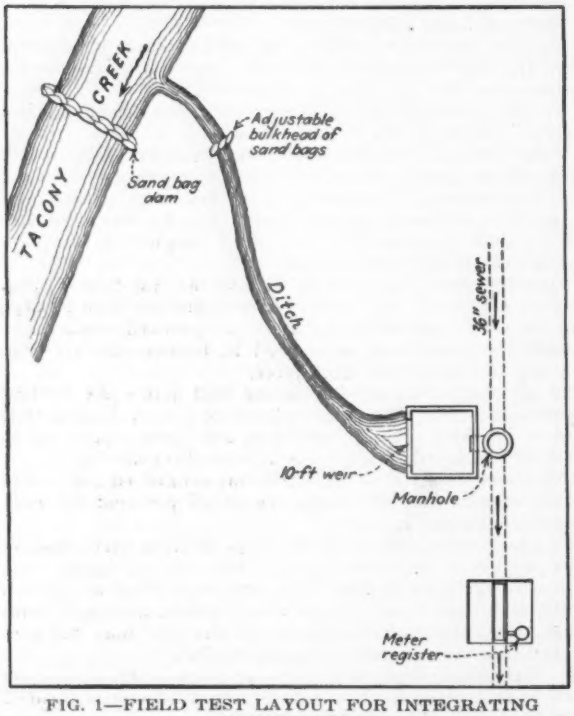


FIG. 1—FIELD TEST LAYOUT FOR INTEGRATING FLUME METER

in convenient units; while c and n are constants. With this granted, it is evident that by determining the flow Q for two depths, the constants c and n can be determined for all depths.

The flow through the flume can be determined in the field by means of a current meter, a pitot tube or a weir, all well-known devices for obtaining approximate results. The experiments on which the method was developed were made with accurate hook gages and Fairbanks scales in the hydraulic laboratory of the University of Pennsylvania.

Recently the city of Philadelphia constructed a 36-in. sewer to take the sewage from Montgomery County into the Philadelphia sewer system. To meter this sewage, as a basis for payment by Montgomery County for the service, it was decided by the city engineers to make use of the principle above described.

TABLE I—GAGINGS OF SEMICIRCULAR FLUME

H_1 in Ft.	H in In.	q	H_1 in Ft.	H in In.	q
0.0895	3.07	0.620	0.307	6.91	3.752
0.0950	3.17	0.677	0.311	7.00	3.825
0.101	3.25	0.740	0.322	7.24	4.023
0.121	3.62	0.964	0.328	7.33	4.133
0.123	3.84	0.987	0.329	7.33	4.151
0.128	3.94	1.047	0.391	8.20	5.342
0.148	4.16	1.293	0.496	9.82	7.560
0.165	4.33	1.516	0.499	9.86	7.626
0.196	4.92	1.949	0.522	10.25	8.145
0.202	4.99	2.037	0.523	10.33	8.168
0.205	5.06	2.081	0.544	10.65	8.652
0.231	5.64	2.477	0.546	10.68	8.698
0.252	5.85	2.806	0.548	10.70	8.746
0.260	6.05	2.944	0.584	11.32	9.583
0.278	6.31	3.250	0.655	12.69	11.345
0.282	6.44	3.315	0.774	14.67	14.474
0.294	6.70	3.505	0.801	14.96	15.220
0.298	6.75	3.593	0.808	15.23	15.414
0.302	6.80	3.664			

H_1 and H = depth of water on weir and in flume. $q = 21.04\ H_1^{1.48}$, calculated from weir depth.

To determine the flow through the sewer, a 36-in. tee was provided, and a channel about 200 ft. long was dug from this tee to Tacony Creek, where a pond was formed by a sandbag dam. In the channel close to the tee was constructed a weir approximately 10 ft. long, with end contractions. Some 40 ft. below the tee a cast-iron section of the sewer was provided, consisting of a semicircular invert and a concrete chamber with manhole, as a housing for a meter to be installed subsequently. In the channel near the dam was placed a bulkhead of sandbags, which, by removing one or more of the top bags, provided a flow which varied as desired from the minimum to the maximum. This weir was actually 10.04 ft. in length, and the depth on the weir was measured by means of a hook gage reading in feet and thousandths. The depths in the semicircular flume were measured at the same time as the weir depths. (See Table I.)

The meter float and register were designed according to the values given in Table II. A test of the results on the ground, made on Oct. 31, 1927, gave results shown in Table III.

The basic assumptions and derivation of formula follow:

By plotting H_1 against H it was found the results conformed closely to a straight-line equation in the form:

$$H = 16.91H_1 + 1.612 \qquad (2)$$

TABLE II—VALUES OF VARIOUS ELEMENTS USED IN DESIGN OF METER AND REGISTER

H	z	V	h	v
1.612	0	0	0	0
1.614	0	0.0006	0.002	0.374
1.712	0.0022	0.1802	0.098	0.930
2.000	0.0158	1.3045	0.372	1.289
2.500	0.0529	4.3692	0.835	1.583
3.000	0.1015	8.3876	1.287	1.773
3.500	0.1591	13.1430	1.729	1.921
4.000	0.2242	18.5220	2.164	2.044
4.500	0.2959	24.4470	2.592	2.150
5.000	0.3735	30.8650	3.015	2.246
5.500	0.4567	37.7360	3.431	2.333
6.000	0.5449	45.0260	3.843	2.413
6.135	0.5703	47.1230	3.953	2.435
6.500	0.6379	52.7070	4.250	2.488
7.000	0.7354	60.7620	4.653	2.558
7.500	0.8371	69.1670	5.051	2.625
8.000	0.9429	77.9020	5.445	2.688
8.500	1.0525	86.9660	5.836	2.748
9.000	1.1659	96.3340	6.222	2.806
9.500	1.2829	106.0000	6.605	2.862
10.000	1.4036	115.9700	6.984	2.916
10.500	1.5271	126.1800	7.361	2.968
11.000	1.6542	136.6900	7.734	3.018
11.500	1.7835	147.3700	8.105	3.067
12.000	1.9176	158.4400	8.470	3.115
12.500	2.0539	169.7000	8.834	3.162
13.000	2.1928	181.1800	9.195	3.207
13.500	2.3350	192.9300	9.553	3.252
14.000	2.4797	204.8800	9.908	3.295
14.500	2.6274	217.0900	10.261	3.338
15.000	2.7773	229.4800	10.611	3.380
15.500	2.9299	242.0900	10.958	3.422
16.000	3.0854	254.9400	11.303	3.462
16.500	3.2429	267.9500	11.643	3.502
17.000	3.4035	281.2200	11.984	3.542

$q = 5.386z^{-}$

The principle of the proposed meter is shown in Fig. 2. The formula for the weir was taken as

$$q = 21.04H_1^{1.46} \quad \ldots\ldots (3)$$

$$q = 0.3388\,(H - 1.612)^{1.46} \quad \ldots\ldots (3a)$$

$$x = \frac{(H - 1.612)^{1.46}}{15.899} \quad \ldots\ldots (3b)$$

The meter was so designed that the vertical movement of the float x would be in direct ratio to the flow through the flume, and to obtain the stipulated range of flow from 1 to 15 m.g.d. with the standard meter register, the formula was taken as

$$q = 5.386x \quad \ldots\ldots (4)$$

The water float balanced by the cylindrical mercury float below was so shaped that the results conformed to equations 3a and 4.

If we let r equal the radius of the cylindrical float and r_1 its rise out of mercury; $\pi r^2 r_1$ the corresponding volume of the cylindrical mercury float, whose height is r_1; h and y the abscissas and ordinates of the shaped water float; R the radius of the mercury vessel, we have the following relations:

$$r_1 = \frac{R^2 x}{R^2 - r^2} \quad \ldots\ldots (5)$$

$$\pi r^2 r_1 = \frac{V}{S} \text{ and for } R = 0.8,\ r = 0.7 \quad \ldots\ldots (6)$$

If we let the specific gravity of mercury be 13.58, we shall have the volume of the shaped water float V equal to $12.58 \times S$, the volume of the cylindrical mercury float, whose height is r_1 on the assumption that the mercury float is under water. It is evident the volume of the shaped float will be:

$$V = \pi y^2 \int dh \quad \ldots\ldots (7)$$

From equations 5 and 6 we have

$$V = 82.627x \quad \ldots\ldots (8)$$

$$q = V \div 15.343 \quad \ldots\ldots (9)$$

From equation 3a it is seen that when $H = 1.612$, $q = 0$ and $x = 0$. Therefore

$$H = h + x + 1.612 \quad \ldots\ldots (10)$$

Substituting for q, H and x their values in equations 3a, 9 and 10, we have

$$82.627h + V = 26.273V^{\frac{1}{1.46}} \quad \ldots\ldots (11)$$

From these equations by differentiating we have

$$y^2 = \frac{1.4370}{\frac{1}{V^{0.31506}} - 0.05464} \quad \ldots\ldots (12)$$

The values given in Table II are computed from the formulas given, for various assumed values of H.

RÉSUMÉ

$$h = \frac{26.723V^{1.46} - v}{82.627} \quad \ldots\ldots (13)$$

$$H = 6.6507x^{\frac{1}{1.46}} + 1.612 \quad \ldots\ldots (14)$$

$$H = h + x + 1.612 \quad \ldots\ldots (10)$$

$$h = 6.6507x^{\frac{1}{1.46}} - x \quad \ldots\ldots (15)$$

$$h = 6.6507x^{0.68494} - x \quad \ldots\ldots (16)$$

$$y^2 = \frac{1.4370}{\frac{1}{V^{0.31506}} - 0.05464} \quad \ldots\ldots (12)$$

$$h = H - \frac{(H - 1.612)^{1.46}}{15.899} - 1.612 \quad \ldots\ldots (17)$$

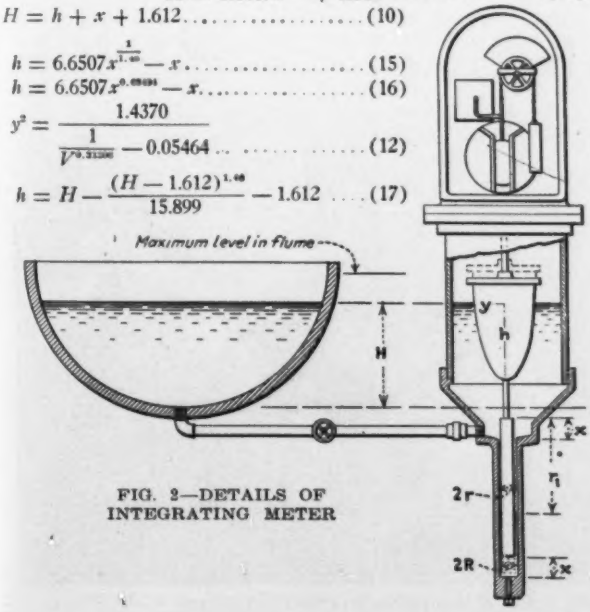


FIG. 2—DETAILS OF INTEGRATING METER

TABLE III—OBSERVED RESULTS WITH METER AND REGISTER

(H_1) Observed Head on Weir Feet	(H) Observed Flume Depth, Inches	(q) M.G.D. From Formula $q = 21.04\,H^{1.46}$	(q) M.G.D. as Indicated by Meter	Difference	Percentage of Error
0.0895	3.07	0.620	0.6005	—0.020	—3.22
0.095	3.17	0.677	0.6472	—0.030	—4.43
0.101	3.25	0.740	0.6963	—0.044	—5.95
0.121	3.62	0.964	0.9374	—0.027	—2.81
0.123	3.84	0.987	1.0911	+0.024	+2.44
0.148	4.16	1.293	1.3273	+0.034	+2.63
0.165	4.33	1.516	1.4585	—0.057	—3.76
0.196	4.92	1.949	1.9430	—0.006	—0.31
0.202	4.99	2.037	2.0033	—0.034	—1.67
0.205	5.06	2.081	2.0877	+0.007	+0.34
0.231	5.64	2.477	2.5902	+0.113	+4.57
0.252	5.85	2.806	2.7897	—0.016	—0.57
0.260	6.05	2.944	2.9840	+0.040	+1.36
0.278	6.31	3.250	3.2426	—0.007	—0.22
0.282	6.44	3.315	3.3745	+0.059	+1.78
0.294	6.70	3.505	3.6430	+0.138	+3.94
0.298	6.75	3.593	3.6954	+0.102	+2.84
0.302	6.80	3.664	3.7480	+0.084	+2.30
0.307	6.91	3.752	3.8650	+0.113	+3.01
0.311	7.00	3.825	3.9608	+0.136	+3.56
0.322	7.24	4.023	4.221	+0.198	+4.92
0.328	7.33	4.133	4.320	+0.187	+4.52
0.329	7.33	4.151	4.320	+0.169	+4.07
0.391	8.20	5.342	5.307	—0.035	—0.66
0.496	9.82	7.560	7.323	—0.237	—3.14
0.499	9.860	7.626	7.375	—0.251	—3.29
0.522	10.250	8.145	7.890	—0.255	—3.13
0.523	10.330	8.168	7.997	—0.171	—2.10
0.544	10.650	8.652	8.430	—0.222	—2.56
0.546	10.660	8.698	8.533	—0.165	—1.90
0.548	10.700	8.746	8.4971	—0.249	—2.85
0.584	11.320	9.583	9.3564	—0.227	—2.37
0.655	12.690	11.346	11.345	0	0
0.774	14.670	14.474	14.421	—0.053	—0.37
0.801	14.960	15.220	14.894	—0.326	—2.14
0.808	15.250	15.414	15.336	+0.078	+0.51
Average error					—0.55

$$q = 5.386x \quad \ldots\ldots (4)$$

$$V = 82.627x \quad \ldots\ldots (8)$$

$$x = \frac{(H - 1.612)^{1.46}}{15.899} \quad \ldots\ldots (3b)$$

The great simplicity of the solution of this problem is evident to any mathematician who has sufficient interest to go through it. The salient points are that V is in direct ratio to the flow, and for V in cubic inches and q in million gallons per day, $V = 15.341q$. This simplification is due to the design of the essential parts of the meter. The next remarkable feature is the simple straight-line equation between H and H_1. The final point of interest is the equality of a volume of revolution having variable ordinates with a volume of revolutions having constant ordinates, enabling us to place equal to each other the first derivative of V with respect to h for the cylindrical volume and the corresponding first derivative of the volume with variable ordinates. It will be noted that the maximum apparent error is about 6 per cent and the average error throughout the range of the experiments was 0.55 per cent. The accuracy is, in the writer's opinion, as close as can be expected in an achievement of this nature, which is believed to be unique in hydraulic meters. In this particular case the results were based on the accuracy of a rectangular weir with end contractions, which under the conditions of the observations could not be expected to reach accuracies closer than from 3 to 5 per cent.

The fourth column of Table III was calculated from the formula $q = 0.3388\,(H - 1.612)^{1.46}$ and that is the reason why the numbers were carried out to four significant figures. There may be a doubt whether the meter itself would register as closely as the percentages of error in that table would indicate. The reason we use the figures based on this formula is that this series of observations of H and H_1 was the most complete and carefully made that we had.

After these observations were taken an official test (see Table IV) of the meter was made in the presence of the engineers of the city of Philadelphia, Mr. Scho-

TABLE IV—OFFICIAL TEST OF METER, DEC. 21, 1927

(H_1)	(q) Calculated From the Weir Depths	(q) Observed Readings of Meter Register	Difference	Percentage of Error
0.124	0.999	1.023	+0.024	+2.40
0.125	1.010	1.068	+0.058	+5.74
0.164	1.502	1.428	—0.074	—4.93
0.172	1.610	1.608	—0.002	—0.12
0.185	1.791	1.798	+0.007	+0.39
0.245	2.698	2.738	+0.040	+1.48
0.340	4.345	4.483	+0.138	+3.17
0.427	6.072	5.853	—0.217	—3.57
0.522	8.143	7.748	—0.395	—4.85
0.526	8.232	7.848	—0.384	—4.56
0.529	8.302	7.948	—0.354	—4.27
0.608	10.174	10.288	+0.114	+1.12
0.624	10.568	10.548	—0.020	—0.19
0.726	13.183	13.248	+0.065	+0.49
0.734	13.394	13.368	—0.026	—0.19
0.748	13.769	13.628	—0.141	—1.02
0.805	15.325	15.868	+0.543	+3.55
0.813	15.592	16.068	+0.476	+3.06
0.849	16.565	16.868	+0.303	+1.83
0.858	16.823	16.948	+0.125	+0.74
Average error				+0.37

H_1 = the weir reading in feet.
q = m.g.d.

field and Mr. Burton; the Montgomery County engineers; Albright & Mebus, represented by Mr. Friel and his assistant, and the engineers of the Simplex Valve & Meter Company, Sweeten and Glover. While the float of this meter had some slight inaccuracies, they were not sufficient to change the results materially.

From an inspection of equation 3a it is seen that when the depth in the flume is 1.612 in. the flow is zero. At first this would seem illogical, for with any appreciable depth in the flume, there must be an appreciable flow; but this represents the limitation of the problem, and from a practical standpoint the performance results, due to this phase, are satisfactory.

The observations in Table I show that with a depth of water in the flume of 3 in. the flow was about 0.6 m.g., and as the maximum flow in the same table is about 15 m.g., the range of the instrument is from 1 to 25, and by the formula 3a with a depth of 1.712 in. in the flume, the flow is shown to be 0.117 m.g.d., or a range of 1 to 130.

The question might arise as to how the contour of the meter float could be calculated if the relations between H_1 and H did not conform to a straight-line equation. In answer to this it may be said that so long as the flow over the weir is any function of the depth in the conduit it is practicable to design the float to comply with this functional relation.

The only limitations of a meter of this kind are where conditions downstream from the meter register are permitted to cause back water, as would be the case if a valve were intermittently throttled downstream from and close to the meter.

Ingenious Bridge Erection Reduces Falsework

Methods Developed for Two Bridges Involve Bracket Falsework and Cantilever Erection of Simple Truss Span

TWO BRIDGES have recently been completed, one a railway structure in Alabama and the other a highway toll bridge over the Missouri River, on which ingenious construction has made possible the elimination of much of the falsework necessary with usual erection methods. In one case a rock bottom made piledriving difficult if not impossible, and in the other falsework was not advisable because of a shifting sand bottom and possible high water and ice. The two erection methods were developed by the engineers of the Kansas City Bridge Company, which was the contractor for both pier construction and steel erection on the bridges.

Black Warrior River Railway Bridge Near Demopolis, Ala.

The new single-track bridge of the St. Louis & San Francisco Railway over the Black Warrior River near Demopolis, Ala., on its new line from Aberdeen, Miss., to Pensacola, Fla., was erected without the use of any falsework in the river channel. The bridge consists of

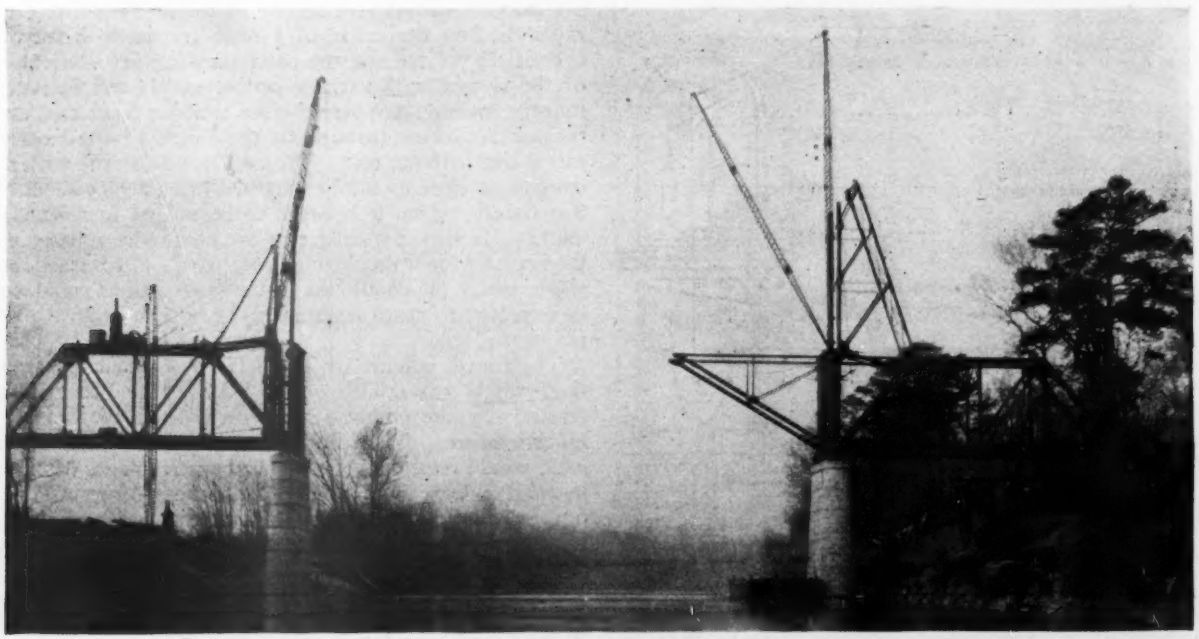


FIG. 1—ERECTING BRACKET FALSEWORK FOR BLACK WARRIOR RIVER LIFT-SPAN

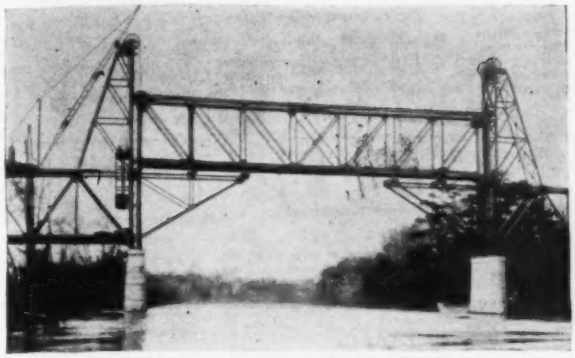


FIG. 2—BLACK WARRIOR RIVER SPAN ERECTED ON BRACKET FALSEWORK

trestle approaches and three steel spans—two through-truss side spans of 100 ft., and a vertical lift center span 184 ft. long with a 22-ft. lift. This center span weighs 294 tons and was the part of the bridge for which no streambed falsework was required.

Two conditions at the bridge site pointed directly to the advisability of using no falsework. Black Warrior River is navigable to Birmingham, one to six or seven boats daily passing the bridge site, so that it was necessary to keep a channel open during construction. In addition, the river at this point ran in a rock trough, making piledriving difficult if not impossible, and ran at such a speed that any falsework erection possible would have been exceedingly difficult.

The side spans were erected with ordinary falsework. The first plan for the erection of the lift span was to drive falsework bents as far out into the stream as possible, leaving a narrow ship channel open. Because of the rock this method was abandoned and a scheme of using cantilever or bracket falsework was devised. As shown in Fig. 1, a bracket arm projected outward from each main pier. This arm was 52 ft. long and its timber anchor bent was approximately 30 ft. high, made up of eight 12x12-in. posts. The horizontal member of the bracket consisted of two 12-in. 25-lb. channels, while the main inclined member was made up of two 15-in. 40-lb. channels. Angle-iron web members were used.

Steel was brought in on barges and unloaded into a storage yard. Derricks set up on the ground erected the side spans. On the north side a mast derrick with a 115-ft. mast and a 100-ft. boom was placed on top of the timber bracket bent, where it erected half of the center span and the north counterweight supports. On the south side an A-frame derrick was placed on the approach span, from which position it erected the remaining half of the center span. It was then moved shoreward on the side span until it was in position to place the south counterweight supports. The lift span was made of material from an old bridge and both the bottom and top chords were in three sections. The two splices occurred at the ends of the bracket arm so that the center section of the bottom chord could span between the brackets. In Fig. 2 the span is shown erected on the brackets, the north side to the right.

The center span was erected slightly above its usual lifted position. After erection was complete and counterweights were added, the span was lifted from the timber bents and the brackets removed.

FIG. 3—BLACK WARRIOR RIVER RAILWAY BRIDGE COMPLETED WITH COUNTERWEIGHTS IN PLACE

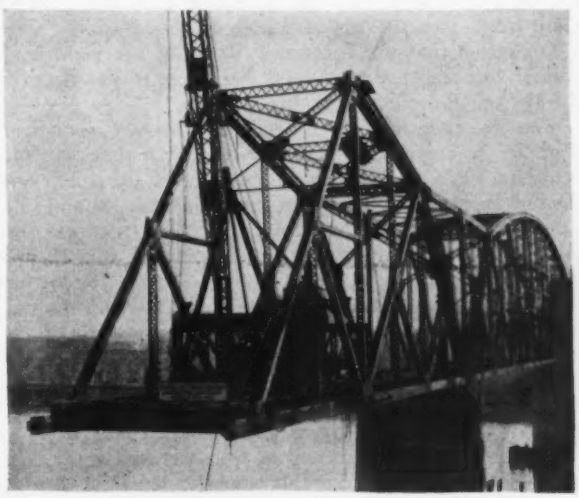


FIG. 4—CANTILEVER ERECTION OF SIX PANELS FORT BELLEFONTAINE BRIDGE
Note tie member between top ends of end posts of adjacent spans.

Missouri River Highway Bridge at Fort Bellefontaine, Mo.

Foreseen erection difficulties on a through-truss highway bridge at Fort Bellefontaine, Mo., occasioned by the deep and shifting sand bottom of the Missouri River at that point and the possibility of floods and ice led the contractor to devise an interesting scheme of cantilever erection, reducing falsework to a minimum. The bridge is a toll structure of four 444-ft. spans with a 20-ft. concrete roadway supported on concrete piers. The crossing of the Chicago, Burlington & Quincy Railway parallels the highway bridge and a temporary track placed outside of the Burlington trusses was used to transport some of the lighter steel members and all of the concreting materials for the piers. As shown in Fig. 6, the steel work followed closely behind pier construction.

The steel spans were redesigned in the contractor's office to permit the use of a method of partial cantilever erection. Important changes in the structure itself necessitated by the erection method included a change from carbon to silicon steel of members U6-L8, U8-L8, U8-L10 and L12-M13. On member U6-L8 the size

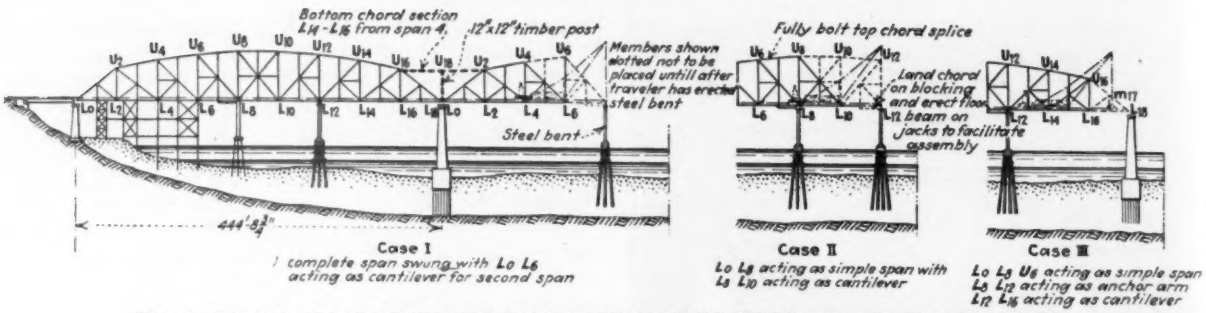

Bottom chord section L14-L16 from span 4.
12"x12" timber post
Members shown slotted not to be placed until after traveler has erected steel bent
Steel bent
Fully bolt top chord splice
Land chord on blocking and erect floor beam on jacks to facilitate assembly
Case I
1 complete span swung with Lo L6 acting as cantilever for second span
Case II
Lo L8 acting as simple span with L8 L10 acting as cantilever
Case III
Lo L8 U8 acting as simple span
L8 L12 acting as anchor arm
L12 L16 acting as cantilever

FIG. 5—PARTIAL CANTILEVER ERECTION METHOD ON THE FORT BELLEFONTAINE BRIDGE OVER THE MISSOURI RIVER

and weight of the member were also increased. In addition to these changes, stiffener angles were provided on the floor beams at L0, L8, L12 and L18 where jacks were used, and the top and bottom chord splices were arranged so that the former occurred at the right-hand end of top chord sections and the latter to the right of the bottom-chord panel points.

The erection method is diagrammatically shown in Fig. 5. It required the use on the first span of conventional timber falsework under the first six panels and steel falsework bents under panel points 8 and 12. Erection of spans 2, 3 and 4 required the use of steel falsework bents only under panel points 8 and 12 and the use of a timber frame on piers 2, 3 and 4 supporting the center of a tie member between the tops of the end posts of adjacent spans. This tie was made up of the end bottom-chord sections of span 4.

On the first span, after erecting and completely riveting the trusses from L0 to L8 with the exception of the top chord splice at U6, cantilever erection was used to L10, followed by the erection of the steel falsework bent under panel point 12 and the completion of the bridge to this point. In no case were the front trucks of the traveler allowed to pass beyond the riveted truss members.

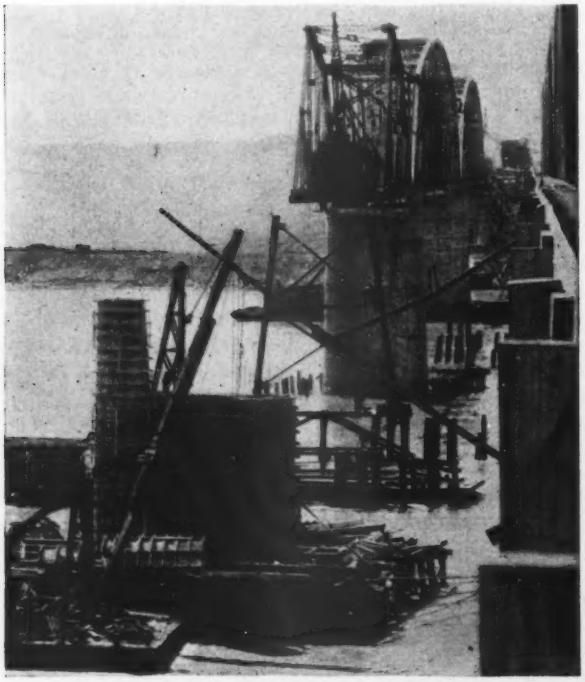


FIG. 6—ERECTING ONE OF THE STEEL FALSEWORK BENTS
Note construction track outside of trusses of adjacent railway bridge.

Jacks were used to jack both panel points L8 and L12 several inches above final grade so that the necessary adjustment could be made when the span was ready to be swung. The top chord splice at U6, although not riveted, was fully bolted until erection reached panel point 12. The bolts were then removed and the connection left free to move during cantilever erection beyond panel point 12. Any time that this splice opened more than $\frac{7}{8}$ in. the jacks under panel point 8 were lowered until it closed again.

The last lower-chord section of each span was placed on blocking with the floor beam at this point resting on jacks. As these jacks were raised the span swung free of the falsework bents under panel points 8 and 12. These bents were then removed and the end of the span was lowered to its final position.

Erection of spans 2, 3 and 4 followed the same procedure as that used for span 1, with the exception of the use of the tie bent between the end posts of the adjacent trusses. Also, rocker shoes were placed under the L0 point of the trusses until that part of the truss between the pier and the steel falsework bent under L8 was completed; the rockers were then replaced by fixed shoes.

According to the contractor, the Kansas City Bridge Company, this method not only eliminated the hazard of having a large quantity of falsework in the river but materially speeded up the work. Harrington, Howard & Ash, consulting engineers, Kansas City, were engineers for the Alton-St. Louis Bridge Company. H. P. Treadway is president and O. A. Zimmerman is chief engineer of the Kansas City Bridge Company. J. P. Coughlin was superintendent in charge of foundations, and C. F. Tupper was superintendent in charge of steel erection.

Federal-Aid Highways

A total of 9,753 miles of federal-aid highways were improved in the calendar year ended Dec. 31, 1928, by the 48 state highway departments and that of Hawaii, in co-operation with the U. S. Bureau of Public Roads. Of that total, according to figures compiled by the bureau, 7,625 miles had not previously been improved with federal aid, while 2,128 miles which had already been so improved were brought to higher stages of construction. These figures bring the total mileage improved with federal aid, as of Dec. 31, to 76,075 miles. In the federal-aid system are a total of 188,017 miles. At the end of December 9,216 miles of federal-aid roads were under construction and 1,597 miles were approved for construction.

Behavior of Rivers in Alluvial Flood Plains

Largely Observations Indicating That a Crooked Alignment Is Due to Excess of Resistance and That Shortening Is Continually Taking Place

By Roy N. Towl
Consulting Engineer, Omaha, Neb.

SINCE one-third of the vast sum voted by Congress for flood control is to go for river revetment to "nail down" the Mississippi in its present location, analysis of the behavior of the river and its tributaries is not out of place. We must avoid detached elements as the sole basis of a theory. Traditions of the past must be laid aside. Let us see what has happened and try to find out why the straight river does behave so well compared with the misbehavior of the crooked river. This recital will be based entirely on the behavior of streams and not on hypothetical theories. Ultimately correct theories will be developed in harmony with the facts.

What makes the Mississippi River straight for many miles below St. Louis and below New Orleans? Also, what makes it exceptionally crooked below the mouth of the Arkansas River in the Greenville bends? These questions are not answered by the *Saturday Evening Post* article of Nov. 3, 1928. The writer, Judge Harris Dickson, states that $100,000,000 will be spent by the United States to keep the Mississippi River crooked, because if straightened it will have 50 per cent greater velocity and 800 per cent greater destructive erosive power. The writer of that article probably never heard of the straight courses of the Amazon where it has a depth of 200 ft. or the extremely crooked courses of the Purus, tributary to the Amazon, which meanders through a dense forest jungle with a depth of 50 to 75 ft.

Straight vs. Crooked Rivers

The following comments are provoked by the age-old debate of straight vs. crooked rivers. It is like the situation in eastern Arkansas, where in the midst of the Grand Prairie we find certain timbered and apparently elevated areas designated as Lost Island, Maple Island, Angelico Island, etc. However, these areas are not raised islands but actually depressions which hold water and support forest growth. So also the usual bends in an alluvial stream seem to disprove the law of direct movement of forces, when actually these same streams have direct general courses, modified only by local departures in proportion to resistances encountered.

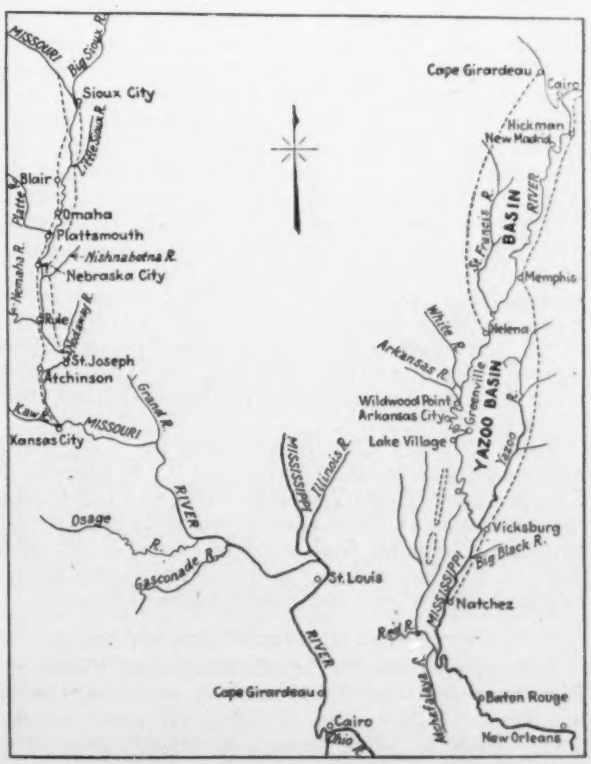
Investigations of the behavior of rivers should be governed by rational methods of analysis, whereby significant characteristics will determine controlling features as the basis of plans in conformity with natural tendencies. The topography of an alluvial valley is the last engraved record of its formation.

Many alluvial rivers have been considerably straightened within the past century. Their behavior indicates natural tendencies with respect to energy and resistance. Energy tends to make a river straight and enlarge its cross-section. Resistance causes a local departure from a direct course and reduces the discharge capacity. A strong man makes a fairly direct course through a crowd of people; local departures are proportional to the man's energy modified by the crowd's resistance.

Some Straight Courses—The Missouri River has a direct general course on the line of the Big Sioux River extended from Sioux City to Kansas City. Likewise, the lower Illinois River is straight. Also, the Mississippi from St. Louis to Cape Girardeau is remarkably straight and does not have the destructive erosive power found in crooked courses. From Cairo to Red River the average low-water slope is 4 in. per mile. Resistances are found in clay deposits in swamps and backwaters, coarse materials near overflow streams, silt, sand, heavy timber growths thrown into the river by caving banks, wrack heaps, rafts, bars, islands and other obstructions. Through all of these resistances the river maintains a direct course, with only local departures proportioned to its energy modified by obstructions.

Timothy Flint, a missionary, about 1819, when the first steamboat appeared on its waters, described the Missouri River below St. Charles as having the appearance of a field of dead trees. Then there were many loops and rapidly caving banks, and cutoffs were being made from Omaha to Sioux City, giving the "Big Muddy" its notorious reputation.

Nineteenth century civilization, with sawmills and snagboats, has reduced resistances of timber and snags



LOWER MISSOURI AND MISSISSIPPI RIVERS

and, to a degree, irregular banks. The Missouri River from the Sioux to the Platte shortened its course 35 miles from 1857 to 1927 as measured on the Nebraska meander. The Lewis and Clarke distance of 1804 has been shortened 78 miles by the 1890 survey of 175 miles. Since the time when cutoffs occurred prior to 1882 the Missouri has not lengthened its course. Shortening of the Mississippi below Cairo was apparently very active from 1864 to 1884, judging from the dates of cutoffs. From 1874 to 1912 government records indicate a shortening from Cairo to Memphis of 21 miles, to Vicksburg 38 miles, to Natchez 44 miles and no increase since that time.

Good Navigability on Straight Stretches

Straight and Stable—The straight stretches of the Missouri and Mississippi have good navigability. The heavy slope of 16 in. per mile below Plattsmouth, Neb., apparently has not increased the maximum velocity of the Missouri River over that found above Omaha, where the slope is 8½ in. per mile. Its straight courses are also better stabilized than the crooked portions of the river, and the latter are very unstable. In this case, from Plattsmouth to Nebraska City, the straight river is less than 10 per cent longer than a direct course and the crooked course from Omaha to Blair is 42 per cent longer than a valley distance of 24 miles. The straight course maintains greater width and lower flood levels. Treacherous bends, with an average slope of 10 in. per mile from Sioux City to St. Louis, 800 miles by river, have cross-currents, turbulent flow and eddy action against caving banks. The narrow bed in a bend has an appearance of a sloping sand dam, around which the river flows with high velocity against the caving bank with destructive scour and erosion.

Meanderings—The Mississippi from St. Louis to Cape Girardeau is less than 10 per cent longer than a direct valley course. From Cairo to Hickman the stream length is 27 per cent longer than the valley course. Similarly from Hickman to New Madrid it is 94 per cent; New Madrid to Memphis, 53 per cent; Memphis to Helena, 54 per cent; Helena to Wildwood Point, below the Arkansas River, 56 per cent; Wildwood Point to Lake Village, 183 per cent; Lake Village to Lake Providence, 51 per cent; Lake Providence to Vicksburg, 70 per cent; Vicksburg to Natchez, 68 per cent; Natchez to Red River, 55 per cent. The total length from Cairo to the mouth of Red River is 773 miles. The direct distance is 468 miles, making a departure of 305 miles, or 65 per cent of the direct distance via the above-named points. These figures indicate that this section of the Mississippi is about three times as crooked as the Missouri River from Sioux City to St. Louis.

From Arkansas City to Greenville the flood slopes measured down the valley range from 0.1 ft. per mile to 5 ft. per mile. From Wildwood Point to Lake Village the oscillations of bends have a total right and left departure of 10 miles from a direct course of 30 miles down the valley, making, as noted above, the excess length of 183 per cent in a river distance of 85 miles.

Tributaries Dictate River's Route

Tributary Influence—The tributaries of the Mississippi River have a very significant influence on the location of the channel. They seem to dictate the route for the parent stream to follow through its alluvial valley. The Ohio has a sufficient contribution of energy to attract the Mississippi, from its former west-side course from St. Louis to Cape Girardeau, across to the east side of the valley. The next departure of moment is found at the return of flood waters east of Sikeston Ridge at the mouth of St. John's Bayou near New Madrid. Thence the general course follows the east side to Memphis. Next we observe a valley crossing from east side to west side, finding the efficient channel in the Helena reach, below the mouth of the St. Francis, which returns flood waters for months after the passage of a flood crest. After passing the White and Arkansas rivers on the west side the Mississippi is recalled to the east side of its valley by the inflows of the Yazoo and Big Black rivers. Then the course continues on the east side past the mouth of the Red River, where it refuses to go to the west side as it does in all other cases cited above. However, we find a marked change in slope below Red River, but here the Mississippi is subject to Gulf influence. This behavior at the mouth of Red River is like the sluggish lower Illinois, where principal tributaries repel the main stream and crowd it to the opposite side of its valley. If the Arkansas River had entered from the east, the course of the Mississippi might have been almost entirely along the east side of its valley, and a natural floodway or bayou system established on the west side from Cape Girardeau to the Gulf, somewhat similar to the Rangoon River parallel with the Irrawaddy in Burma.

Influence of Levee Construction

Levee construction has changed natural conditions. Overflow has been excluded from the St. Francis Basin, excepting backwater from below. Also it is excluded from the Yazoo Basin. At Arkansas City and Greenville high stages are increased by the excessively crooked channel. Concentrated energy has made it difficult and expensive to hold the crooked course. Here is where the only east-side crevasse of 1927 occurred—at Mounds Landing, above Greenville. The valley distance of 30 miles has 85 miles of river channel formerly subject to overflow. This concentration of flood waters by levees naturally would make a shorter channel as it approaches stability.

In the opinion of the writer, W. E. Elam is not warranted in his fears, expressed in his article on "Flood Control Through Slope Correction," in *Engineering News-Record*, June 28, 1928, of the possibility of excessive slope on tributary streams, resulting from channel improvements on the Mississippi River. Certainly uniformity of flow is most desirable. Flow across the point of a bend not only causes slack water in the bend, reducing discharge, but it increases erosion and scour at the lower end of the bend, where the channel is narrowed by a sloping bar formation made by the cross-currents in conflict with the main stream. I am advised that low water at St. Louis has been lowered 4 ft. by channel improvements designed to produce more uniformity of flow and to reduce erosion.

The Arkansas River has a south-side levee for about 100 miles from Pine Bluff to Napoleon at its mouth, and a north-side levee for the westerly half of that distance. Its course has been shortened about 25 per cent during the past 100 years, judging from a comparison of the subdivision meander and the 1927 survey.

Clean vs. Silty Streams—The White River has the behavior of a clear-water stream. It flows parallel with the Mississippi River for many miles. The Arkansas River has the behavior of a silt-burdened stream as it approaches the Mississippi. At Pine Bluff the Arkansas channel is on the south side of its valley, and as it ap-

proaches the mouth its course tends toward the left side of the delta formation.

Probably the mouth of the Arkansas River used to be through Cypress Creek Bayou, on the south, and the mouth of White River through the present Arkansas channel. Within the backwater area of the Mississippi River the overflow of the Arkansas has formed an accumulation of sediment, drift and débris on the south side, which has apparently shifted its channel northerly through the course of years. Upon reaching its present location the Arkansas no doubt forced a new connection for the White River directly into the Mississippi River.

The present connection of the White and Arkansas rivers, known as the White River cutoff, is in a cypress swamp 4 or 5 miles from the Mississippi River, where it has held that position during the past 100 years.

The Red River shortened its course 20 per cent in 100 miles below Shreveport, La., between 1891 and 1908. Increased energy to produce this shortening came through levee construction and removal of obstructions.

The Platte, largest tributary of the Missouri, has a direct course across the State of Nebraska. Its slope decreases from 100 in. per mile to about 40 in. per mile. However, its flood velocity is quite uniform. The Missouri below Plattsmouth has flood slopes, for short distances, as great as 30 in. per mile. These slopes are maintained until bars are sufficiently submerged and cut away by the rising flood waters to bring back equilibrium between slope and other elements of discharge. This behavior of an unstable bed applies to the Mississippi and furnishes a prime factor limiting flood velocities.

Where River Is Straightest

The straightest course on the lower river is below New Orleans, where the slope is ¼ in. per mile and subject to Gulf influence. Here we find no cutoff lakes or evidences of channel changes, no forests or resistances similar to those encountered by the river in the Greenville area. So the river has good velocity with great depth—as much as 100 ft. at low water. It makes and keeps a straight course.

The straightest course on the upper river is from St. Louis to Cape Girardeau. At St. Louis it receives the inflow of the Missouri on the west side of the valley; the slope is 7 in. per mile. Again we find the Mississippi with a big store of energy on account of slope making and keeping a straight course, but without the 800 per cent destructive erosive disaster, noted by Judge Dickson in the *Post* article.

Finally, it is well to realize that the Greenville bends are a result of resistances, which might well be removed, except for the fact that Vicksburg interests would not care to have the Greenville congestion transferred downstream. Then, be it remembered, in a 40-day flood storage factors must be considered with due respect to all increments of inflow. Also be it remembered that efficient channels leading to spillways or points of diversion will expedite the passage of floods at reduced peak stages.

If the banks of the Mississippi are very soft, almost like brown sugar, it should be relatively an easy matter to maintain a straight course. For example, there is a remarkable section of the Missouri River above the mouth of the Little Sioux on the boundary of Nebraska and Iowa. Here the straight river runs between banks of sand on both sides—there are no gumbo points or heavy timber. It has held this course without protection work for more than 50 years. The width is 0.67 mile, compared with 0.33 mile average width in a series of bends. So it is evident that the factors of slope, width and depth are stabilized without producing excessive velocity or erosive action.

Flood velocities of the Platte, Missouri and Mississippi are substantially the same, from 4 to 5 m.p.h., regardless of slopes. So why is it not reasonable to conclude that the middle section of the lower Mississippi will function as well after straightening as other sections which are now straight?

Following is an abstract from the special report of the Mississippi River Commission, Nov. 28, 1927, paragraph 343: "In an unsettled region and on an unleveed alluvial stream a program of cutoffs and bank protection begun at the lower end of the river to be treated and, progressing upstream, would, if velocities were held within limits to protect navigation, be unobjectionable and might be desirable in anticipation of settlement of the region." The writer appreciates that such a condition does not now exist on the Mississippi. But the statement is significant of the commission's official attitude toward the basic principle involved.

Prohibited Parking in Chicago Raises Traffic Efficiency

After Fourteen Months' Trial No-Parking in Loop Found Not Prejudicial to Business—Cuts Accidents and Arrests

RESULTS of prohibited parking in the central business district of Chicago have been astoundingly in favor of that method of traffic control. Business has not been adversely affected, the facility and safety of traffic movement have been greatly augmented, accidents are fewer, the number of police required is less and parking arrests have decreased 27.7 per cent.

Chicago's no-parking ordinance has been in effect since Jan. 10, 1928. At that time it was agreed that at least 90 days should elapse as a trial to make such minor adjustments as inevitably would be necessary, as well as to give the public a chance to adjust itself to the new ruling. After a total expenditure of $125,000 by various agencies, including the street traffic committee of the Chicago Association of Commerce, the city and the merchants for a comprehensive study of the traffic situation, the committee sponsored this ordinance because the engineering data pointed to no-parking as giving the highest percentage of efficiency from the available street area. Plenty of adverse opinions, though backed by no data, were voiced in the first few months of the trial, but the committee and the authorities paid no attention to the criticisms, awaiting the verdict of cold facts to be determined after a sufficient trial had been made. These facts can now be summarized after more than a year's trial.

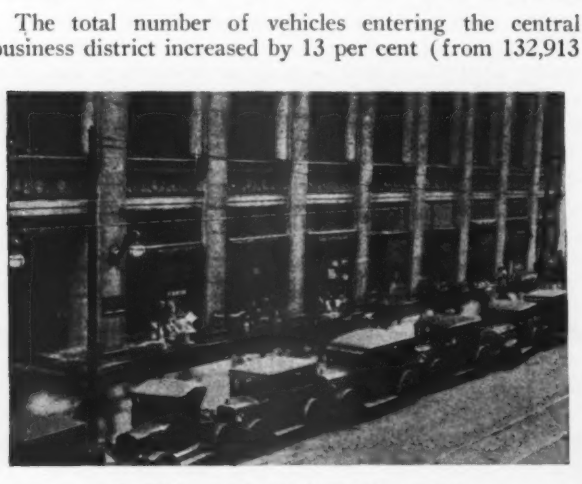
Business Not Affected—As to the effect on merchandising in the district (essentially the Loop, six by nine blocks in size), all developments can be explained by normal business growth and by general economic factors. A few specific facts are not without interest. Two large department stores whose sales figures are available show substantial gains over 1927. One was 7 per cent higher for the first quarter of 1928 than for the first quarter of 1927. The other reports 15 per cent more February business than in 1927. Certain drug, food and

clothing establishments have expanded during the period. Occupied floor area in office buildings in May of last year was 324,815 sq.ft. in excess of October, 1927. During the year 1,500,000 sq.ft. of rentable area was added.

Traffic More Active—Perhaps the largest factor in business done is the number of people entering a given district. The total number of passengers entering the central district on a typical business day in May of 1928 from 7 a.m. to 7 p.m. was 894,059, as compared with 870,859 in May, 1926, an increase of 2.6 per cent within two years. During that period transportation showed these changes:

Surface street car lines carried	1.03 per cent fewer passengers
Elevated (high speed) lines carried	4.95 per cent fewer passengers
Steam railways carried	4.41 per cent more passengers
Motor bus lines carried	6.94 per cent more passengers
Passenger automobiles carried	18.33 per cent more passengers

The total number of vehicles entering the central business district increased by 13 per cent (from 132,913 to 150,189). The following table shows the increase and decrease in the two-year period of the various street units entering the district:



BEFORE THE NO-PARKING RULE
Clark St. at Washington St., 11:30 A. M., Jan. 9, 1928

Surface cars decreased	0.62 per cent
Motor buses increased	35.75 per cent
Passenger automobiles increased	18.33 per cent
Trucks increased	5.18 per cent
Horse-driven vehicles decreased	36.00 per cent

A further index to vehicle characteristics within the central district is to be found in the volume of movement of various classes of traffic at different points within the area. Comparisons were made on the basis of volume checks conducted in July and August, 1926, and during April and May, 1928. Counts at 28 selected locations in the district showed an increase of 4.13 per cent in movements into the intersections.

A count of pedestrians entering the Dearborn-Madison St. intersection on Saturday from noon to 5 p.m. indicated 105,692 for May, 1928, as against 103,530 two years previously, an increase of 2,126 persons, or 2.09 per cent. Another count of individuals on State St. between Madison and Monroe Sts. from 11.30 a.m. to 6 p.m. showed 133,587 for May 29, 1928, against 95,631 for Nov. 25, 1925.

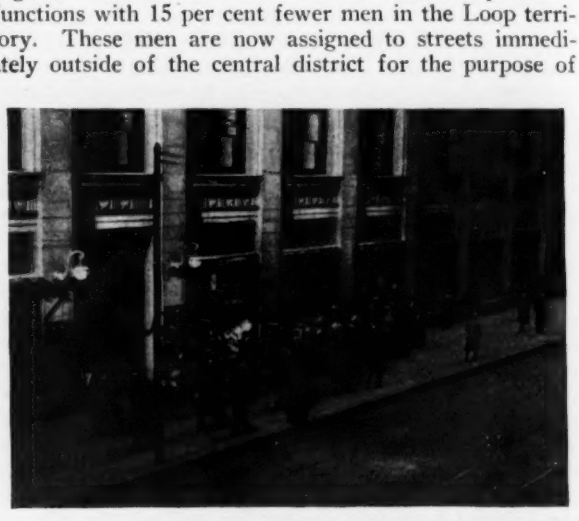
The passenger automobile is the only mode of personal transportation that could be adversely affected by prohibited parking. The studies made show that so far as the passenger automobile is of service to the central district its utility has not only been increased but, in comparison with auto registration increase and other measurable factors, increased disproportionately during the period of observation. Registration increased 13.7 per cent and entering autos 18.3 per cent.

Street Cars More Efficient—As to facility and safety of traffic movement, the movement of street cars has been greatly facilitated and, as this agency brings the largest number of passengers to the district, its increased efficiency is of major importance. Comparative daily counts of passengers brought to the district are 282,013 for the surface street cars and 196,873 for automobiles. An official of the surface lines states that prohibited parking has decreased the running time within the Loop 15 to 25 per cent.

The automatic traffic signals, which were formerly adjusted for a speed of 10 miles per hour, are now operated so that traffic has been speeded up 15 to 55 per cent.

An Improved Safety Record—Accident rates have decreased. The fatal, non-fatal and property damage cases (total) decreased from 1,100 in 1927 to 947 in 1928, falling off 13.9 per cent. There was an increase of fatalities both in the Loop and Chicago as a whole. The decrease is due to the fewer number of property damage cases. A slight increase in personal injury accidents occurred.

Has the regulation entailed more expensive or oppressive administrative methods? The answer is in the negative. The traffic division of the Police Department functions with 15 per cent fewer men in the Loop territory. These men are now assigned to streets immediately outside of the central district for the purpose of enforcing parking rules and to prevent double parking. The public is less annoyed by parking arrests—21,550 arrests in 1928 as compared with 29,823 in 1927.



AFTER THE NO-PARKING RULE
Same part of Clark St., 11:30 A. M., Jan. 10, 1928

When to park and what to do with a car in the central district is a question that has been investigated. Off-street storage facilities have increased materially in the Loop. In 1926 space for only 8,732 cars were available. In May of 1928 space for 14,571 cars was found by the committee survey. Paid space in Grant Park now serves 500 more patrons daily than in 1926. Two years ago Wacker Drive with facilities for parking more than 1,700 cars was under construction and not available. It is now in use.

As a result of the year's study the street traffic committee still recommends a continuance of the no-parking policy and the encouragement of the development and use of off-street storage facilities in commercial garages and in Grant Park.

Railway Engineering Discussed at Three-Day Meeting of A.R.E.A. in Chicago

Steel Highway Bridge Specifications Adopted—Economy of Treated Timber Bridges and Permanence of Concrete Discussed—Revised Manual to Be Published This Year

COMPLETION of 30 years of activity by the American Railway Engineering Association was marked at its annual meeting in Chicago March 5-7 by every evidence of increasing activity. Membership has increased during the year, as did attendance at the meeting. The proceedings showed also that committee work had expanded. All suggestions for improving and enlivening the procedure of the annual meetings having been rejected last year by the board of direction, the 1929 convention followed closely upon the usual lines, though with a rather exceptional amount of discussion at times. This may have been due in part to personal letters sent by the president to various members, requesting them to discuss the reports at the meeting. Two little flurries which pleasantly ruffled the rather too smooth procedure were objections to discontinuing the investigation of roadway deformation and a controversy over certain recommendations concerning grade-crossing protection. On the other hand, many important subjects were passed without comment and the committee on electricity presented in succession a series of fifteen sub-committee reports to a handful of members, most of these reports being simply brief notes of progress. The entire program was disposed of at the six long business sessions. Announcement was made that the long-promised new edition of the "Manual of Recommended Practice" is now expected to be issued in 1929, it being explained that its publication was delayed last year owing to the desires of some committees to improve their parts of the work. The one lady member, Miss Olive W. Dennis, engineer of service, Baltimore & Ohio Railroad, responded to a request for a few remarks and later received an ovation when she presented a sub-committee report on motor-coach, motor-truck and rail-motor service in relation to railway operation. Another ovation was given to the young grandson of the secretary, E. H. Fritch, who was hailed as a future secretary. At the convention hall there was an exhibit of the instruments used in the triangulation survey for the Cascade tunnel, described in *Engineering News-Record* of Feb. 28, p. 334.

An innovation in the procedure was the closing of each morning session with a personal address, as a change from the series of committee reports. Maj. Gen. Edgar Jadwin, Chief of Engineers, U. S. Army, spoke on the relation of railway engineers to military service and the relations between railway and waterway transportation. The Suisun bridge, now under construction to supersede the Carquinez Straits car-ferry, was described by C. R. Harding, engineer of standards, Southern Pacific Railway, and "The Radio in Railroad Transportation" was dealt with by O. H. Caldwell, formerly of the Federal Radio Commission. One evening was assigned for visiting the railway appliance exhibition at the Coliseum. The second evening was the occasion for the annual dinner, with three principal addresses: "Railroad Problems," by W. R. Cole, president of the Louisville & Nashville Railroad: "Legislation and Railroad Consolidation," by James S. Parker, Member of Congress and author of the Parker bill to facilitate consolidation projects; and "Railroads and Commerce," by Vincent Massey, Minister from Canada to the United States.

Committee Reports

Since 27 committees presented reports on a long list of subjects through their numerous sub-committees, space permits only a summarized review of the reports and discussions.

Roadway and Track—A proposition of the committee on roadway to discontinue the subject of roadbed deformation was strongly objected to by E. R. Lewis (Michigan Central) on the ground that drainage is one of the most important but one of the most neglected factors in the consideration of roadbed as the foundation for the track. This view was expressed also by George E. Ladd, consulting geologist, who referred to numerous examinations made for railroads. On the other hand, Robert H. Ford (Rock Island) agreed with the committee that the subject has been treated amply in previous reports, but the meeting voted in favor of having the investigations continued.

As to concrete foundations for track, mention was made of settlement of the track slabs in the Chicago union station. To remedy this, holes were drilled, mud was forced out by compressed air and then grout was forced in beneath the slabs. Revised specifications for washed gravel were submitted by the committee on ballast, but as objection was made to the proposed field test, the committee agreed to consider some more effective method by which the engineer may determine if he is getting gravel of the desired quality. Conflicts between sub-committee reports were shown, it being pointed out that while gravel meeting these specifications could be cleaned, like stone ballast, another sub-committee reported that washed-gravel ballast could not be cleaned. For the study of shrinkage of ballast, test sections of track have been established for careful observation. Of four kinds of slag, C. W. Baldridge (Santa Fe) considered granulated slag undesirable as ballast, but A. F. Blaess (Illinois Central) said he had found it very satisfactory.

That railways are adhering closer to the tie specifications was shown by the committee on ties, which also referred to high conductivity of concrete ties as being an important consideration where track circuits are used. The committee repeated its recommendation of last year that both switch ties and ordinary ties should be renewed singly, as required. But this was again referred back to the committee, on motion of Mr. Blaess, who noted that it is often found practicable and economical to renew all the ties of a turnout at one time. A proposed formula for determining a traffic unit in comparing life of ties was strongly opposed as being too indefinite and of uncertain basis. On vote, it was rejected.

In average rail failures per 100 miles of track, the

report of the committee on rail shows that rails rolled in 1922, whose five-year period of observation is now concluded, have a rate of 110 as compared with 98.9 for 1921. This had been predicted, and it is expected that the 1923 rails will approximate the high rate of 119.6 given by the 1920 rails. An appendix to the report on the subject of "Rails and Wheels," by W. C. Cushing (Pennsylvania Railroad), discussed the genesis of transverse fissures. In an interesting review of the work of the rail detector car, E. A. Sperry (president of the American Society of Mechanical Engineers), expressed the hope that it will soon be possible to show the exodus of the transverse fissure. Interesting particulars of the operation of this device were given by Mr. Sperry, W. C. Barnes (engineer for the committee) and L. J. Hughes (Rock Island). The relation of cold rolling under traffic to the formation of fissures was discussed by James E. Howard (bureau of safety, Interstate Commerce Commission). The committee's report showed continuing increase in the number of transverse fissures, 4,742 being the figure for 1927. A statement to the effect that reconditioning worn rail ends by electric or oxy-acetylene welding is not detrimental to the rails, and is recommended as good practice, was accepted for the "Manual."

For superelevation on curves, the committee on track recommended a revised explanation of the formula and also withdrawal from the "Manual" of the present chart on overturning speeds on curves. On the ground of varying conditions affecting curve elevation, B. R. Leffler (New York Central) thought that no table or formula should be given, but only a statement of principles. In reply it was explained that such tables and formulas are recognized as guides and as such to be used with judgment. The committee's recommendations were then adopted. A brief statement as to oiling rails on curves was submitted as information.

In regard to the continual damage to track and bridges by brine dripping from refrigerator cars, W. G. Arn (Illinois Central) explained that there is no uniformity of practice in caring for the brine-retaining devices on the cars. It was pointed out by W. H. Courtenay (Louisville & Nashville) that although the subject has been discussed for several years there has been no relief obtained, in spite of the great amount of damage done.

A progress report of the committee on stresses in track stated that a report of studies on rail joints is practically completed and will be issued soon.

Highway Bridge Specifications

Bridges and Buildings—An important step was the adoption of specifications for steel highway bridges, as prepared by the committee on iron and steel structures, acting jointly with the American Association of State Highway Officials. At the suggestion of M. Hirschthal (Delaware, Lackawanna & Western), the committee will consider reducing the 16-ft. vertical clearance proposed, as such clearance might then be demanded for street subways. The specifications cover structures with electric railway track. As to welding, the committee did not think progress made thus far warrants its use in fabricating steel for railway bridges. The use of copper-bearing steel for structural purposes is widening and the steel can be obtained readily at slight increase in cost. Punching tests have led to these conclusions: (1) Punching makes metal less ductile and raises the elastic limit; (2) the injurious effects may be removed by reaming; (3) subpunching and reaming are as efficient as drilling.

Timber overhead bridges have a very definite field and may be regarded as permanent structures, according to the committee on wooden bridges and trestles, which proposes to develop plans for such structures. Its extended revision of grading rules for timber was adopted for the "Manual." Several speakers referred to the long life of highway bridges of treated timber and to their economy as compared with more expensive construction. Bridges of treated fir that have lasted 23 years on the New York Central were cited by B. R. Leffler, while H. Austill (Mobile & Ohio) stated that as a result of negotiations with the Alabama state highway department the latter has developed a type of timber trestle with concrete slab deck and parapet, the cost of which is about the same as a 4-in. timber deck with composition wearing surface. In this connection may be noted information submitted by the committee on wood preservation as to the use of fir piles and timbers in railway bridges and trestles.

Principles of design for reinforced-concrete columns, submitted by the committee on masonry, were adopted for the "Manual," as were definitions for special cements and the specifications for concrete pipe as prepared jointly with other societies. In view of lack of uniformity in the waterproofing of structures other than bridge decks, the committee plans to prepare an outline for recommended practice.

Revision of specifications for building materials now in the "Manual" were submitted by the committee on buildings and were approved, together with specifications for concrete, wood, asphalt and macadam paving and flooring.

No Agreement on Crossing Protection

Grade-Crossing Protection—Considerable discussion followed the report of the committee on grade crossings, which again submitted a design for a highway crossing sign of the cross-buck type but with a board showing the number of tracks.

For busy crossings and to replace watchmen, the committee recommended flashlight or wigwag signals on each side of the track and in the middle of the street where width permits. Strong objection to this middle location was made by A. H. Rudd (Pennsylvania), who referred also to suggestions made by the committee on signals and interlocking for duplicating flashlight signals. That is, each crossing signal would have two sets of lights, back to back, so as to show in both directions. Then a driver on the highway would see the signals on both sides of the track. With such an arrangement the middle location would be unnecessary or less desirable, while in some states this location is prohibited. On the other hand, this middle location of the crossing signal was indorsed as satisfactory by R. H. Ford (Rock Island) and B. Blum (Northern Pacific), and in the end the committee's recommendation was adopted.

Water Service, Shops and Yards—A series of fourteen reports submitted by the committee on water service and sanitation covered a wide variety of subjects, but included no material for the "Manual." The far-reaching effects of bad boiler water in increasing costs of railway operation were stressed, and it was stated that nearly every water could be improved by treatment or softening. In fact, it was stated that the economy of supplying locomotives with clean soft water is so great that "no imaginable cost of treatment is prohibitive." In this connection J. L. Campbell (Northwestern Pacific) referred to the extreme case of the El Paso & Southwestern Railway (now Southern Pacific System) where water from deep

wells was so bad that no treatment could make it satisfactory, the result of heavy treatment being to cause the water to foam so badly as to impair the operation of the engines. A bold step was taken in building a 140-mile pipe line to bring good water from a distant source and distribute it along the bad-water division.

Other subjects included protective coatings for the interior of tanks and pipes, cleaning pipes from incrustation due to the use of treated water, filters for railway use, securing wells in fine sand, the merits of supply from water columns and tank spouts, design of track tanks, supplying drinking water at coach yards and the promotion of railway sanitation. A report on locomotive sanding facilities submitted by the committee on shops and locomotive terminals, to supplement its previous report on coaling stations, was accepted for the "Manual," as was its report on storage of crude oil and fuel oil.

Principles for the design of coach yards were submitted by the committee on yards and terminals for inclusion in the "Manual." These were adopted and also revisions in the rules relating to weight-cars for testing track scales. Information was submitted also as to facilities for car-to-car transfer in consolidating less-than-carload freight. A study of yard operating conditions which would render desirable a change from flat to gravity switching was included in the report of the committee on economics of railway operation.

Railway Economics—Three reports on economic subjects were passed almost without discussion, though they dealt with important and live subjects. An approximate method of determining the probable economy of electrification was submitted by the committee on economics of railway location. It proposed a short-cut method of determining and applying cost data in studying problems of location and line revision. However, the latter was accompanied by two minority reports objecting to such methods as giving indefinite results, but as the matter was submitted as information no action was taken. Economical lengths of freight trains and the economic effects of double tracking on heavy-traffic lines were among the subjects discussed by the committee on economics of railway operation. Of special interest also was a report on railway operation as affected by railway use of motor coaches, motor trucks and rail-motor cars.

Equating track values for labor distribution, as discussed by the committee on economics of railway labor, led to objection to a table of equated values, and the committee withdrew its recommendation that this matter be included in the "Manual." As to an economic ratio of supervision to labor, the committee presented information but concluded that the subject is an individual problem for each railroad. Additional information as to labor-saving machines was submitted, with the conclusion that substantial economies result when such machines are "carefully selected, efficiently manned and properly supervised and maintained."

Important Valuation Data

Valuation and Depreciation—Two important subjects submitted by the committee on records and accounts were methods and forms for: (*a*) handling the Interstate Commerce Commission's requirements as to depreciation charges, and (*b*) keeping up to date the physical and valuation records of railroad property. Its specifications for the design and printing of record forms and its form for track foremen's daily reports of material were adopted.

The report pointed out that the commission's order covering depreciation involves both engineering and accounting, and these must be handled together as a unit. In some respects the provisions prescribed by the order are impracticable. That this report is of exceptional importance in regard to valuation and depreciation matters was remarked by E. F. Wendt, who pointed out that these subjects involve not only accounting methods but also legal and economic aspects. This year the Interstate Commerce Commission's tentative order on depreciation will go into effect and engineers will then have an opportunity to determine the principles and methods to be followed in this part of the valuation work.

Contract and Agreement Forms

Miscellaneous—A form of cost-plus-percentage construction contract, submitted by the committee on uniform general contract forms, was adopted for the "Manual." Progress reports dealt with agreements for joint terminals, wire crossings over railways and purchase of electricity, and with a form of application for industry tracks. Last year the committee characterized as unnecessary a proposal to prepare a form of agreement for the use of railway property for public highways, but after warm discussion it consented to reconsider the matter. It now repeated its opinion that the subject is one for individual handling and that no uniform style can be established. Its recommendation that the subject be dropped was adopted. The committee on rules and organization submitted rules for certain classes of employees and a list of proposed uniform titles for officers below the rank of division engineer. These were adopted.

The new committee on rivers and harbors made its first report, which was mainly of a descriptive character. It dealt with the protection of riverbanks, the construction and protection of levees, methods of taking soundings in rivers and tidal waters, and the allowable excess depth in dredging to insure the desired operating depth. Allowance for swell in scow measurement of dredge work was suggested as follows: hardpan and sand, 0 to 5 per cent; sand and gravel, 5 to 10; clay and hardpan, 10 to 20; clay or stiff mud, 30 per cent maximum. There was no discussion, but at the suggestion of P. T. Simons (Missouri Pacific) the committee will add land drainage to its program.

As preliminary to the preparation of diagrams and rules for clearances, the committee on clearances recommended that nine committees (on bridges, buildings, yards, water service, etc.) prepare clearance diagrams as a basis for study. A long report by the committee on standardization discussed the reorganization of what is now the American Engineering Standards Association and reviewed a long list of organizations affiliated in the work of standardization. An interesting appendix showed to what extent the Illinois Central Railroad uses or diverges from the numerous items of A.R.E.A. "recommended practice."

A progress report of the committee on relations with universities suggested the advantages that are available to the railways through some plan for selecting young men with a background of college training. A review of methods used by industrial concerns in selecting students for employment was presented by W. C. Cushing (Pennsylvania), who suggested the use of similar methods by the railways. In particular, he thought the candidate for a position has a right to know the conditions of engagement and the prospects for his advancement.

Facts Bearing on the Chicago Sanitary District Dilemma

What Has Been and Must Be Done to Meet the Situation Caused by the U. S. Supreme Court Decision, With a Bit of Historical Background

WHAT the Chicago Sanitary District has accomplished thus far in the way of sewage treatment is outlined in two tables and accompanying notes printed farther on. The figures and their interpretation are pertinent just now in view of the decision of the United States Supreme Court on Jan. 14 that the district cannot lawfully divert water from Lake Michigan for purposes of sanitation and that what it may legally divert for navigation in the Chicago River is negligible compared with what it has been diverting. Charles E. Hughes will hear testimony in Chicago on March 25 to guide him in formulating the terms of the court decree for approval or amendment by the court. At this hearing, presumably the Lake states, on whose complaint, in the interests of navigation, the decision was rendered, will be heard, as also the Sanitary District, the latter in part by some of the eleven consulting engineers appointed to advise the district, as noted on p. 286 of *Engineering News-Record*, Feb. 14, 1929. For an account of some of the difficulties confronting the district, more particularly grand jury findings as to political and financial mismanagement, see *Engineering News-Record*, March 7, 1929, p. 396.

Genesis of Sanitary District

By way of background it may be noted that the Sanitary District of Chicago was created by an act of the Illinois State Legislature, May 29, 1889, to divert from Lake Michigan the flow of the Chicago River with its burden of city sewage, by means of a canal 28 miles long between the Chicago River and the Des Plaines River, which flows ultimately into the Mississippi River. With the sewage, the canal was to divert water from the lake at a rate fixed in the act at $3\frac{1}{3}$ sec.-ft. per 1,000 population of the district. In fixing this rate of dilution the legislature substituted $3\frac{1}{3}$ for the 4 sec.-ft. recommended by the Drainage and Water Supply Commission of Chicago in January, 1887, which report also advised the construction of the Drainage Canal. The members of this commission were Rudolph Hering, chief engineer, Benezette Williams and Samuel G. Artingstall. To Hering is credited the simple rule just mentioned for the ratio between population and flow of water in case of sewage disposal. The main conclusions of the commission's report and the substance of a paper reviewing the data on which Mr. Hering based his dilution rule may be found in Fuller's "Sewage Disposal" pp. 224-30. The paper mentioned, "Notes on the Pollution of Streams," was read before the American Public Health Association in 1887, *Trans.* A.P.H.A., Vol. 13.

At the outset the Sanitary District had an area of 185 square miles and a population (1890) of 1,150,000. Enlargements brought the area to 442 square miles in 1928, with an estimated mid-year population of 3,540,000, about 210 square miles and some 3,100,000 of the population being in Chicago. The 59 other municipalities range in population from 70,000 to a few score, the latter where parts only are within the district. The drainage area of the Chicago River is about 300 square miles.

Although Chicago was incorporated as a town in 1833 and as a city in 1837 (population less than 5,000), it was not until 1855, when the population was 60,000 to 70,000, that E. S. Chesbrough reported on a comprehensive sewerage system for the city. [Twenty years later the report was printed in full in *Engineering News*, Vol. 2 (1875), pp. 42, 55 and 70.] Mr. Chesbrough advised that the sewage be discharged into the Chicago River and its branches, thus to find its way into Lake Michigan; but he considered also three other means of disposal: discharge directly into the lake, discharge "into artificial reservoirs, to be thence pumped up and used as manure," and "into the river, and thence by the proposed steamboat canal into the Illinois River." The Chesbrough report is characterized in Rafter and Baker's "Sewage Disposal in the United States" (1894) as "being, so far as the authors can learn, the first American report in which sewage disposal other than by discharge into the nearest watercourse is touched" upon.

As to diversion southward in connection with navigation, Mr. Chesbrough considered its feasibility too remote, but it was only some ten years later that water from the Chicago River was forced into the Illinois and Michigan Canal, causing diversion of Lake Michigan to the Des Plaines and Illinois rivers, while in 1880 the Fullerton Ave. tunnel and screw pumps were put into use to relieve pollution in the North Branch of the Chicago River, sometimes forcing water away from and sometimes into the lake. In 1883 the Bridgeport pumping station, located at the junction of the Chicago River and the Illinois and Michigan Canal, was put into use and in 1893 it was enlarged. Thus lake diversion began as early as 1865 and was increased from time to time subsequently, until made substantially complete by the opening of the Chicago Drainage Canal in January, 1900. There were some breaks in the diversion in the early years, but ever since the Chesbrough report in 1855, and perhaps before that, lakes-to-gulf navigation and disposal of the sewage of Chicago, both aided by diversion of the water from Lake Michigan, have been coupled at Chicago.

The United States Takes a Hand

The first federal authorization to divert water from Lake Michigan seems to have been a conditional permit, granted by the Secretary of War on May 8, 1899, less than a year after the Drainage Canal was opened. The diversion of 5,000 sec-ft. under this permit was cut slightly on Dec. 5, 1901 to 4,167 sec.-ft. Subsequent applications to increase this amount were denied except for quite recent increases, temporary in character. Diversions in excess of the 4,167 sec.-ft. led to federal action for injunction, which, partly because a federal trial judge pocketed his decision for a half-dozen years.

then merely rendered it orally in favor of the government, delayed the final decision of the U. S. Supreme Court until Jan. 5, 1925. Under this ruling the Secretary of War gave a temporary permit for the diversion of 8,500 sec.-ft., conditioned on the adoption of a complete sewage-treatment program by the district and action by the city of Chicago for complete metering and filtration of its water supply (See *Engineering News-Record*, Jan. 15, 1925, p. 110, for court decision, and March 2, 1925, p. 448, for the permit. An abstract of the findings and recommendations of a board of 28 consulting engineers, created by the Sanitary District to report "on the lake-lowering controversy and remedial measures" appeared in *Engineering News-Record*, Jan. 1, 1925, p. 22, the report being dated Dec. 24, 1924.)

While the federal suit to compel the district to keep within the permit of the Secretary of War was pending, all the states on the Great Lakes except Illinois and Indiana brought suit against the district, asking for an injunction against any diversion, on the ground of injury to navigation. The decision in this suit against the Sanitary District (see *Engineering News-Record*, Jan. 24, 1929, p. 146), forbidding any diversion for sewage-disposal purposes, led to the present situation and the hearing before Mr. Hughes set for March 25. (For the Hughes findings preliminary to the decision just noted, see *Engineering News-Record*, Dec. 1, 1927, p. 890.)

Sewage-Treatment Operations

Coming now to what has been done in the way of sewage treatment: Following protests against lake diversions and overburden on the diluting water even under the excess diversion compared with the federal permit, sewage-treatment experiments were begun in 1908 and some years later the construction of sewage-works was started. The first of these, a small one, was put into use in 1920, five others since then, and one is nearing completion.

A condensed exhibit of the six sewage-works already built and the one now under construction by the Sanitary District is given in the accompanying table, compiled from a 108-page descriptive pamphlet entitled "Engineering Works, The Sanitary District of Chicago, August, 1928." The kinds of treatment considered suitable for the sewage of the district and the efficiency of each in reduction of solids, biochemical oxygen demand (B.O.D.) and total bacteria are stated as follows on pp. 88, 90 and 92 of the pamphlet:

The Sanitary District has investigated and installed practically all the modern processes of sewage treatment at its testing stations and treatment works. These installations include relatively simple processes such as screens and tanks, which remove only the larger solids; and more complex biological processes such as sedimentation followed by trickling filters or activated sludge, in which the putrescible organic solids, both in suspension and solution, are almost completely oxidized to inert, odorless, mineral compounds. The degree and type of treatment necessary depend upon the amount of dilution available for the effluent. The limited amount of dilution available for the disposal of the sewage and stormwater of the Sanitary District necessitates ultimately a high degree of treatment for its sewage and industrial wastes. The two processes of sewage treatment suitable for the Sanitary District requirements are (1) sedimentation, followed by trickling filters, and (2) activated sludge.

The results obtainable by the sedimentation-trickling filter process of sewage treatment may be summarized briefly. For Chicago conditions, sedimentation, either in Imhoff tanks or in plain settling tanks, removes about 90 per cent of the settleable solids, equivalent to 50 or 60 per cent of the total solids in suspension. This removal of solids reduces the oxygen requirements, as measured by the determination of biochemical oxygen demand, 30 to 35 per cent. Sedimentation, followed by trickling filters and secondary sedimentation, removes from 85 to 90 per cent of the biochemical oxygen demand. This combination also removes 80 to 90 per cent of the suspended solids. The filter effluent may contain from 5 to 10 p.p.m. of nitrate nitrogen, indicating that the ammonia and organic nitrogen present in the raw or settled sewage has been almost completely oxidized and mineralized.

The effluent produced by the activated-sludge process appears somewhat superior at times to that produced by the sedimentation-trickling filter process. It accomplishes from 85 to 95 per cent reduction of the biochemical oxygen demand, 90 to 95 per cent reduction of suspended solids and from 92 to 98 per cent reduction in bacteria.

The six plants listed in Table I as already built, together with the one nearly completed, provide for treatment to varying degrees of efficiency of 636 m.g.d. of sewage from a population of 2,954,000, as of various dates to about 1940, with parts of some of the plants designed for the estimated tributary population of 1960. The population of the district in 1930 is estimated at 3,710,000, but this does not include any allowance for the population equivalent of vast quantities of industrial wastes, notably from the stockyards and packing-house district. Looking ahead for what at that time was

TABLE I—SEWAGE-WORKS COMPLETED AND UNDER CONSTRUCTION BY THE SANITARY DISTRICT OF CHICAGO

Compiled from a descriptive pamphlet issued by the Sanitary District of Chicago as of August, 1928.

Name	Date in Use	Designed Population	For Sewage Flow M.G.D.	Type of Treatment	Approximate Efficiency in Reduction of Suspended Solids	Biological Oxygen Demand	Total Bacteria
Morton Grove....	Dec., 1914, and May, 1920	1,200	0.18	Imhoff tanks and sprinkling filters.....	80-90	85-90	.....
Des Plaines River	Aug., 1922	45,000 *a*	4.50 *a*	Fine screens and activated sludge.....	90-95	85-95	92-98
Calumet.....	Sept., 1922	225,000 *b*	56.00	Imhoff tanks *c*.....	50-60	30-35	.....
Glenview.....	Oct., 1924	1,200	0.18	Imhoff tanks, trickling filters, secondary settling tanks.....	80-90	85-90	.....
Northbrook.....	April, 1925	1,500	0.18	Imhoff tanks, trickling filters, secondary settling tanks.....	80-90	85-90	.....
North Side.....	Oct., 1928	830,000 *d*	175.00 *d*	Preliminary settling tanks and activated sludge.....	90-95	85-95	92-98
West Side.....	Some time in 1929	1,850,000 *f*	400.00 *f*	Skimming tanks and Imhoff tanks *e*.....	50-60	30-35	.....
		2,953,900	636.04				
S.W. Side.....	In preliminary stages of investigation						

(*a*) Tributary population in 1928 about 66,000; pumping station, grit chamber and blower house designed for considerably larger flow.
(*b*) This population may be reached in 1932.
(*c*) Also, for experiments, a trickling filter unit with secondary settling tank and two activated-sludge units.
(*d*) Portions of the works which can be readily extended were designed for the "estimated 1930 human population of 800,000," according to the August, 1928, pamphlet issued by the Drainage District, but later figures put the population at 830,000, to be connected late in 1929. Parts not readily enlarged are designed for 1960.
(*e*) Excess activated sludge from North Side works pumped 17 miles to West Side works.
(*f*) As of 1940; main pumping station, grit chambers, coarse screens and conduits designed for 1960.

twenty years, Edward K. Kelly, chief engineer, Sanitary District of Chicago, in an article published in *Engineering News-Record* March 4, 1926, p. 363, estimated at 6,785,000 the population to be provided for in 1945, including an allowance for industrial wastes in equivalent human population. In round numbers this is 7,000,000 population, against 3,000,000 actual human population that will have been provided for in 1930, assuming that the West Side works will be completed by that time.

To indicate what the works built and under construction signify in terms of 100 per cent efficiency (complete treatment), Table II has been computed in terms of equivalent population, using the combined populations for each type of plant and the corresponding rated efficiency percentages. Summing up for the three types of treatment combined and using round numbers, the seven plants provide for complete treatment of the sewage of 2,000,000 in terms of suspended solids removed and 1,500,000 for B.O.D. (biochemical oxygen demand), or for two-thirds and one-half of the population of 3,000,000 tributary to the seven plants. Compared with

TABLE II—EQUIVALENT POPULATIONS ON 100 PER CENT TREATMENT EFFICIENCY BASIS TRIBUTARY TO SEWAGE-WORKS OF CHICAGO SANITARY DISTRICT

	Efficiency, Per Cent	Population Served	Population on 100 Per Cent Efficiency Basis
Activated sludge		875,000	
Suspended solids	92.5		809,000
B.O.D.	90		788,000
Bacteria	95		831,000
Imhoff tanks and sprinkling filters		3,900	
Suspended solids	85		3,000
B.O.D.	87.5		3,000
Imhoff tanks		2,075,000	
Suspended solids	55		1,141,000
B.O.D.	32.5		674,000
All three		2,954,000	
Suspended solids			1,953,000
B.O.D.			1,465,000

7,000,000 population (human plus equivalent allowance for industrial wastes), the seven plants will effect less than 30 per cent reduction in suspended solids and more than 20 per cent in B.O.D.

The official pamphlet from which were taken the efficiencies for the various types of works thus far presented took no account of bacteria reduction except for the activated-sludge process, for which Table II shows an equivalent of 830,000 population at complete removal. This is for total bacteria. Imhoff tanks combined with sprinkling filters should receive considerable credit and the tanks alone somewhat less for reduction of dangerous bacteria and consequent lessening of the burden on water-purification plants. This credit is sometimes put equal to the reduction in suspended solids. Applying this liberal allowance to the plants other than those of the activated-sludge type gives 1,760,000 population at 100 per cent reduction of harmful bacteria, which, added to the 830,000 population already stated for the activated-sludge plants, gives about 2,600,000 as the equivalent population at 100 per cent bacterial efficiency, taking into account works completed or to be finished by 1930.

As to sewage-works not yet put under construction, Mr. Kelly's paper already mentioned indicates that, aside from many small scattered plants, presumably of small total capacity, an immense plant to be known as the Southwest Side plant would complete the program as laid out in 1926. For this area, what may be termed preliminary treatment for stockyards and packing houses and for corn products wastes was then contemplated, the effluent to go to the Southwest Side works and be treated there. The sewage and industrial wastes tributary to this plant appear to be equivalent to the ordinary sewage from 2,500,000 population at present and perhaps 3,500,000 by 1945, presumably requiring complete treatment for a population as large as that of the seven works already built or nearly completed, or 50 per cent in excess of these seven works reduced to a 100 per cent efficiency basis.

The foregoing figures, however tentative they may be as to new plants and extensions to old ones to give complete treatment, will serve to indicate roughly how much the Sanitary District of Chicago must yet do in the way of construction.

Some Cost Figures

Cost figures to the close of 1927, given in the official pamphlet of August, 1928, showed a total capital outlay of $205,000,000, including nearly $7,000,000 provided by the city of Chicago (for connections with the canal?). The larger sum includes over $31,000,000 bond interest. The $205,000,000 is divided into $125,000,000 for "dilution system and appurtenances" and $80,000,000 for "sewage-treatment system." Each of these sums includes various sewers and pumping stations. Interest charges against dilution were $19,000,000 and against treatment $12,000,000. No interest on Chicago's contribution is entered. Taking into account construction outlay and bond interest in the fourteen months since Dec. 31, 1927, the capital outlay for sewage diversion and treatment may be well toward $225,000,000.

The treatment works thus far built, although extensive and in line with the district's program adopted before the first of the two U. S. Supreme Court decisions and approved in substance by the 28 engineers making up the engineering board of review appointed by the district in 1924 (see *Engineering News-Record*, Jan. 1, 1925, p. 22), leave much to be done in the way of sewage treatment. Many data that will aid in formulating the larger program have been gathered by experimental work in progress since 1908, about the time the district began to be hard pressed by the federal government on the one hand and on the other by those interested in navigation.

For the district there remains a huge further expenditure for sewage-works and accessories, while for the city of Chicago there will be required vast outlays for water purification and possible water-supply tunnel extensions to lake intake points less likely to pollution than the present ones whenever heavy rains or offshore winds restore to lakeward the flow of the Chicago; or in case the Supreme Court makes it imperative to discharge some of the treated sewage lakeward.

Steel Triangulation Towers Prove Value

During the past season a triangulation party under E. O. Heaton, an engineer of the U. S. Coast and Geodetic Survey, established a record for the department by running nearly 600 miles of first order arcs in only 108 elapsed days. The work was through rolling country in Iowa, Missouri and Arkansas. Bilby steel towers, such as were described in *Engineering News-Record*, Aug. 9, 1928, p. 215, were used, giving a tripod height of 90 ft. During the survey 100 main-scheme stations were established; nearly one per day. The average closing error of the triangles was 0.8 second.

News of the Week

Railway Engineers Learn of Expanding Activities at Chicago

President Tells of Change in Railway Transportation—Association Continues Its Growth

PRESENT and prospective changes in the transportation system were noted in the presidential address at the annual meeting of the American Railway Engineering Association, held at Chicago March 5-7. It was pointed out by the retiring president, W. D. Faucette, chief engineer of the Seaboard Air Line, that highway traffic is already reducing the short-haul movements, both passenger and freight, and further reduction may be expected, while air transport is likely to affect passenger business to an increasing extent. This problem is not simply a matter of opposing competition. It indicates that a new instrumentality has changed business, social and civic customs and has created a new condition, which the railways must and can meet. He did not look for much new railroad construction in future, but rather for the improvement of existing lines and especially their facilities for handling traffic economically. As possible future developments in the association's work he suggested new rail design, new or modified track structure, and especially the training of men for the control and administration of railroad properties. In closing he referred to the probable issue of the new "Manual" this year, which was predicted also in the secretary's report.

A total membership of 2,790 was shown by the report of the secretary, E. H. Fritch, this being a net gain of 183. There are 783 members serving on the 27 committees. Attention was called to the increasing number of executive officers in the membership. These total 203; engineers, 1,846, other railway officers, 159; professors and engineers not in railway service, 582. Receipts for 1928 were $58,088 and expenditures $55,764, while the balance on hand is $56,326. A feature of the association's activities is its co-operation with and representation in numerous organizations in whose work the railways have an interest.

Attendance records were again broken for the fourth consecutive time, the registration totaling 1,403, of whom 402 were guests. At the 1928 meeting the corresponding figures were 1,316 and 348 respectively. All of the 27 committees had reports printed in advance, making about 1,290 pages, and as most of the committees have from five to fifteen sub-committees (nearly all reporting), the total number of reports presented amounted to approximately 140.

A report of the technical sessions is given on p. 437 of this issue.

Louis Yager Elected President

Louis Yager, assistant chief engineer, Northern Pacific Railway Company, St. Paul, Minn., was elected president of the association on March 7. G. D. Brooke, general manager, Chesapeake & Ohio Railway, was advanced automatically from the position of second vice-president to first vice-president to succeed Mr. Yager, and L. W. Baldwin, president of the Missouri Pacific System, was elected second vice-president.

Louis Yager

E. H. Fritch was re-elected secretary, and F. J. Stimson was re-elected treasurer. A. K. Shurtleff, assistant secretary, an active member of the association and formerly with the Union Pacific Railroad, has been retired on pension, having reached the age of 70 years.

Mr. Yager, the new president, has been a member of the association since 1911, has been a vice-president for the past two years and was a director from 1923 until 1926. He has served on the association's committees on ties, rail, and economics of railway operation.

Mr. Yager is a graduate of the University of Minnesota in civil engineering of the year 1900. Immediately upon graduation he entered the service of the Northern Pacific Railway as a rodman and inspector of bridge construction, subsequently becoming assistant engineer and then supervisor of bridges and buildings, which position he held until, in February, 1907, he was made assistant engineer in charge of construction of the St. Louis Bay interstate bridge at Duluth-Superior. After two years on this work and a year on branch-line construction, he was made engineer in charge of the Eastern district, a position which he held until January, 1917, when he was appointed engineer, maintenance-of-way, lines east, Northern Pacific Railway. From July, 1919, to April, 1920, Mr. Yager served as chief maintenance-of-way engineer, United States Railroad Administration, Washington, D. C. Upon the completion of this work he returned to the Northern Pacific as assistant chief engineer.

Proposes to Develop St. Lawrence River by Five State Trustees

New York State Governor Recommends Development by the State and Private Distribution

DEVELOPMENT of the power on the St. Lawrence River which is available within the boundaries of New York State by "the Trustees of the Water-Power Resources on the St. Lawrence River" is proposed in a bill submitted to the state legislature by Governor Roosevelt on March 12. He would appoint five trustees, "who shall include an engineer, a lawyer familiar with public law in this field, and a banker, to study and report plans and a form of contract for the sale and distribution of hydro-electric power to be generated at water-power sites on the St. Lawrence River, owned or controlled by the people of the state." The dams and power plants are to be built, financed, owned and physically operated by the trustees. For this purpose the trustees are to be established as a corporate municipal instrumentality of the state, perpetual in duration, whose bonds and other securities, while not backed by the state, shall be instrumentalities of the state and tax exempt.

Distribution and sale of the power shall be by private agencies if such agencies will undertake the work under the conditions laid down—namely, that rates to consumers shall be such as to bring a net return not in excess of 8 per cent on the actual cash investment. The rates shall not be subject to the rate-regulating powers of the Public Service Commission.

Trustees are to be appointed for five years and to serve without pay other than expenses. They are to employ the necessary engineering, legal and financial assistance required to prepare a plan or plans for the proposed development to be submitted to the state legislature on or before Jan. 15, 1930, and to carry out the work when approved by the legislature.

Contracts Awarded for Bridge Over the Kill van Kull

Contracts for the piers for the approaches to the Kill van Kull Bridge between Bayonne, N. J., and Port Richmond, Staten Island, were awarded on March 8, by the Port of New York Authority. The nineteen columns on the Staten Island side will be erected by the Arthur McMullen Company, of New York City, for $314,780. The firm was low among nineteen bidders. The eighteen piers at Bayonne will be built by the P. T. Cox Contracting Company, Inc., of New York City, for $387,930. It was the lowest of thirteen competitors. The piers will be of reinforced concrete of height ranging from 20 to 110 ft. The two contracts involve totals of 1,150,000 lb. of structural steel, 2,100,000 lb. of reinforced steel and 27,700 cu.yd. of concrete.

International Hydraulic Authority to Visit This Country

Dr. Theodor Rehbock, professor in the Technische Hochschule at Karlsruhe and director of its hydraulic laboratory, known internationally as an authority on river flow and river control, will arrive in this country on March 16. He will visit Washington, D. C., and will also give a series of lectures at the Massachusetts Institute of Technology. The hydraulic laboratory established by him at Karlsruhe has been visited by many hydraulic engineers, who declare that they have learned there in a few hours more relating to their profession than they could have learned otherwise in months and years.

Porter Elected Chairman of Engineering Foundation

H. Hobart Porter has been elected chairman of Engineering Foundation, joint research instrumentality of the Founder Engineering Societies, to succeed L. B. Stillwell, who has served since 1925. Mr. Porter is president of the American Water Works & Electric Company and of the Brooklyn City Railroad Company. He is chairman of the board of the West Penn Electric Company and vice-president of the Queensboro Gas & Electric Company, as well as a director in many other companies. He is a member of the division of engineering and of the executive committee of the National Research Council; of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society of Mechanical Engineers. He is a trustee of Columbia University, from which he was graduated in 1886 with the degree of M.E.

Mr. Porter was born in New York City in 1865 and was engaged in mining engineering in Mexico and Arizona until 1894, when he became a member of the engineering firm of Sanderson & Porter, New York, with which he has since been identified.

New York to Build Bridge at Hell Gate and Narrows Tunnel

City to Aid Highway Traffic by Crossing to Long Island and Staten Island

THE city of New York has decided to go ahead with the construction of the Tri-borough bridge connecting Long Island with the mainland in the Bronx and with Manhattan Island, and with the construction of a tunnel under the Narrows from Brooklyn to Staten Island, regardless of the outcome of legislation now pending in the state legislature which proposes to set up a "bridge and tunnel authority" to construct these two crossings.

On March 11 the Board of Estimate and Apportionment adopted a resolution directing the Department of Plant and Structures and the Board of Transportation to prepare plans for the construction of the bridge and tunnel, and authorizing the Comptroller to issue corporate stock and serial bonds to cover the cost of the work. Tolls are to be collected to defray the cost of maintenance and construction. Legislative sanction of this method of financing the work is required.

The estimated cost of the two projects is in the neighborhood of $100,000,000. A perspective drawing of the proposed Tri-borough bridge was given in *Engineering News-Record*, March 31, 1927, p. 542. The tentative plans call for a suspension bridge over the East River at Hell Gate close to the present Hell Gate arch bridge and a long viaduct over Wards Island and Randalls Island crossing Little Hell Gate channel and Bronx Kill to the Borough of the Bronx. From this viaduct another branches off across the Harlem River to the Borough of Manhattan.

The location and character of the proposed tunnel under the Narrows have not been determined upon definitely.

New Airport Terminal Planned on Jersey Meadows

Plans for the development of an airport on the New Jersey meadows were announced last week. The site includes 743 acres already purchased, with 165 acres more under contract. It lies just east of the Hackensack River and midway between New York and Newark.

The company which is to develop and operate this air terminal has been incorporated under the laws of Delaware as the New York Air Terminals, Inc. The plan of development includes the construction of a seaplane basin on the northwesterly side with a depth of 45 ft. and an extent of 56 acres, enabling seaplanes to have a run of more than 3,000 ft. for take-off and alighting.

It is announced that the company has a working capital of $3,000,000 cash to be used in developing the proposed terminal.

Iowa's $100,000,000 Highway Bonds Unconstitutional

Iowa's $100,000,000 highway bonds, ranking second in amount to the $175,000,000 Texas program, were unanimously declared unconstitutional on March 5 by the state Supreme Court. The decision is based on the fact that the law does not provide for the retirement of the obligations within 25 years by direct tax, thus violating a fundamental section of the state Constitution. The issues provided for paving all primary roads, totaling 6,300 miles. The state authorities had planned to sell $17,000,000 in April.

Georgia Highways Suffer Little Damage From Two Floods

Although causing considerable inconvenience to the traveling public, high waters in central and southern Georgia, caused by two successive hard rains, have done little real damage to the highways. A rainfall of 4½ in. Feb. 27-28 and another one of 4 in. March 4-5 in the north central part of the state caused five major streams, the Chattahoochee, Flint, Ocmulgee, Oconee and Savannah rivers, to overflow in many places. The Altamaha, formed by the joining of the Ocmulgee and Oconee, has also overflowed its banks. The first flood crest passed through the southern part of the state March 7-8, and the second crest, not as high as the first, was expected in that section March 13. According to state highway officials, no further flood damage is expected, though the streams will remain high for some time.

The damage to highways so far has been confined to minor washouts and the loss of a few small timber bridges. A long fill has been washed out between Mount Vernon and Glenwood. Six persons were drowned Feb. 27 when two cars dropped into a washout on the road between Augusta and Lincolnton. A highway patrol rider had passed over the road a short time previous to the accident.

More actual damage was done by the storm of last September, which swept across the West Indies, Florida and up the east coast, than was done by the present floods, according to the state highway officials. Damage to highways by the present floods is estimated by the highway department to amount to about $100,000.

Aviation Commission Proposed for New York

Governor Roosevelt of New York has signed the bill creating a temporary state commission of ten members and appropriating $40,000 to make a comprehensive study of the needs and requirements of the State of New York and its municipalities with respect to aviation and its development and recommend to the legislature such measures as it may find desirable in relation thereto.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

New Orleans Bridge Project Awaits Report of Engineers—Supporters to Push the Hydraulic Laboratory Bill

FINAL decision from the Chief of Engineers as to whether or not he will grant a permit for the construction of the proposed Hero-Hacket bridge at New Orleans is being withheld until the district engineers at New Orleans have forwarded their report on the revised plans. It is understood, however, that approval is unlikely unless the backers of the undertaking express their willingness to consent to a location farther upstream. Those interested in the project point out that to move the location farther up the river would lessen the opportunity of financial success, since it has been demonstrated that traffic will not go far out of its way to get to a bridge when direct ferry service is available.

Although it has been suggested that the proponents of the project may seek permission to build a tunnel underneath the river in the event of failure to receive a permit for the bridge, it is not expected that much will be done in this connection. It is estimated that a tunnel beneath the river at New Orleans would entail a cost of $25,000,000 to construct and that the revenue to be expected would not justify this expense.

Engineering Council Files Brief for Hydraulic Laboratory

Although the House rivers and harbors committee failed to take action on the Randsell hydraulic laboratory bill before adjournment, the American Engineering Council obtained permission to file a brief completing its testimony in behalf of the measure. This brief, which was prepared by B. R. Van Leer, assistant secretary of the council, will be printed in the document containing the hearings on the project. It is planned to reintroduce the bill during the next regular session. Those interested in the legislation believe that they will be able to expedite their cause if they can have the measure taken before some other committee than the one on rivers and harbors.

In his brief Mr. Van Leer brings out that the Bureau of Standards, as is proposed in the bill, is the only logical location for a national hydraulic laboratory.

Report on Stabilization of Employment

In promoting the stabilization of employment, prime reliance is to be placed on the ability of private industry to work out its own solution of the matter, it is stated in the recent report by the Senate committee on education and labor on the causes and remedies of unemployment. Disapproval is expressed of the suggestion that the government undertake the establishment of unemployment insurance, although it is recommended that private employers be urged to adopt this form of industrial insurance. The chief function of the government in the situation should be in the remodeling of the federal employment service in such a manner as to enable it to co-ordinate the work of the state bureaus, it is proposed. In this connection reference is made to the testimony of experts as to the desirability of a national clearing house for labor statistics.

The causes of unemployment are divided into three classes, cyclical, seasonal and technological. In recommending that the best means of combating cyclical unemployment is through the control of credit, the report directs attention to the results thus far obtained by the Federal Reserve System. As to the two other classes, seasonal and technological unemployment, it is brought out that the most serious problem exists in the technological field, where machinery constantly is supplanting human labor and where old industries steadily are giving way to new ones. No concern should be given to undue consideration of seasonal unemployment, it is pointed out, since most large employers already realize the advantages of spreading production throughout the year as much as possible. It is recommended, however, that because of the complicated nature of the problem of mitigating unemployment caused by mechanical inventions and the changing nature of industry, more attention be given this phase of the situation before legislation is proposed dealing with it.

In concluding, the report calls attention to the beneficial results that would be brought about through the adoption of the Jones "prosperity reserve bill," in which it is proposed that the federal government and other public agencies so order their public works that they will offer a buffer in times of unemployment.

Six-State Colorado Compact Has Been Ratified

With the signature last week by the Governor of Utah on the act of the Utah Legislature ratifying the Boulder dam bill, the last of the necessary six states approved the measure. When Congress passed the bill and it was signed by President Coolidge on Dec. 21 last, a six months' period was allowed for its ratification by the seven states directly involved or, if Arizona persisted in its refusal to come into the compact, then ratification by six other states, including California, was to be sufficient. Arizona, therefore, has until June 21 next for ratification.

After the lapse of the stipulated time and before construction of the dam can begin it is necessary for the Secretary of the Interior to make contracts for power and water sales sufficient to return the cost of construction plus 4 per cent interest. Thus there is much to be done before construction can start, even under the most favorable conditions.

Southwest Road Show and School Held at Wichita

The Fourth Annual Southwest Road Show and School was held at Wichita, Kan., from Feb. 26 to March 1, inclusive. The exposition also included power farming machinery. The attendance exceeded that of any previous year, the total number of visitors passing the turnstile being in excess of 50,000.

Six excellent programs were presented as a part of the road school, five of which were strictly technical and aimed to interest and instruct visiting engineers and county commissioners. Notwithstanding the excellence of the programs, the attendance at them was small; this applies particularly to the first and last programs of the series. A special effort was made to attract attendance by placing on the last program such men as R. W. Crum on "The Work of the Highway Research Board," P. J. Freeman, Bureau of Tests and Specifications of Allegheny County, Pennsylvania, on "Soundness of Aggregates for Concrete," and O. T. Reedy, of the Colorado Highway Department, on "An Analysis of the 5c. Gas Tax." All three of these men are well known in the highway field and their discussions were of the highest grade, but the attendance at the last program was not more than 25. The four programs presented on the intermediate days drew a somewhat larger audience, 200 being the maximum.

The display of roadbuilding machinery was quite up to expectations and included exhibits of manufacturers from ten or more states. Heavy tractors and graders attracted the most attention, and exhibitors of these lines seemed well pleased with the interest taken in their displays. In addition to the heavy equipment, there were several displays of materials and accessories.

Educational exhibits were presented by the U. S. Bureau of Public Roads, American Road Builders Association and the Republic of Mexico; by the state highway departments of Missouri, Kansas and South Dakota, and by two engineering schools.

Some of the exhibitors expressed the opinion that the number of county engineers and county commissioners in attendance was smaller than in preceding years. The decrease in attendance of these officers was ascribed to the recent change in the Kansas highway laws by which all maintenance and construction work on the state highway system was definitely placed in the hands of the State Highway Commission. Heretofore work on the roads in this system has been handled by the counties under the supervision of the State Highway Commission. The change becomes effective April 1.

Mississippi Above Flood Stage

Reports from Memphis state that the Mississippi River at that point is now slightly above flood stage, with rising water. A small crevasse is reported in the main levee on the St. Francis River.

Brief News

CONTRACT for the Windsor end of the Detroit River vehicular tunnel, from the land shaft to the Windsor terminal, has been awarded to Spencer, White & Prentis, Ltd., of Montreal.

THE TORONTO HARBOR COMMISSION has plans under way for the construction on the waterfront of one of the finest seaplane and land plane airports on the continent. It is proposed to locate the landing field, marine railway, hangars and shops on Toronto Island, south of the Western Gap.

AUTHORITY TO INQUIRE into the qualifications of bidders on public works is granted to public boards in Indiana by a bill recently passed by the state Senate. The boards are authorized to inquire into the qualifications of the bidders, their experience, equipment and other facts which may aid in awarding contracts.

THE HUDSON BAY RAILWAY, which will give the western provinces of Canada a short route to tidewater during the season of navigation, has been completed to mile 462, leaving only 48 miles to be constructed during 1929, it is reported by the American Trade Commissioner at Winnipeg, G. B. Richards.

PLANS FOR A BRIDGE over the Wabash River at New Harmony, Ind., being prepared following the granting of a franchise by Congress, are well under way. The plans have to be approved by the War Department before construction can be undertaken, but it is hoped to start work early next summer.

THE WYOMING TAX ON GASOLINE is raised from 3c. per gallon to 4c. by an act that has been signed by Governor Emerson. The law is effective April 15, and by its terms 75 per cent of the money raised will go to the state highway fund, the remainder to the various counties.

APPROXIMATELY 2,000 additional miles of airways will have been completed in the United States by June 30 next, the Department of Commerce states in its publication, *Domestic Air News*, issued March 5. On. Feb. 15 there were 9,567 miles of airways equipped, under construction or contracted for night flying. By June 30 the 2,000 additional miles will have been added.

THE NIPPON ELECTRIC COMPANY, manufacturer of telephone equipment, has awarded the H. K. Ferguson Company, of Cleveland, Ohio, a contract for designing and constructing a third large manufacturing unit at Tokyo, Japan. The new unit, like the two previously built by the same company, will have heavy mat foundations and a structural steel frame incased in concrete and will involve an expenditure of approximately $250,000. It will be of earthquake-resistive design evolved by company's engineers.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 24-26.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston; annual convention, Memphis, Tenn., May 13-16.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

* * *

THE PROVIDENCE (R. I.) ENGINEERING SOCIETY at its meeting on March 26 will be addressed by Lieut. Col. U. S. Grant, whose subject will be "City Planning."

Personal Notes

P. M. DAVIS, consulting engineer, of Los Angeles, Calif., who has been associated with the Southern Crude Oil purchasing Company and the Southern Pipe Line Company, subsidiaries of the Standard Oil Company, has been appointed associate engineer, U. S. Navy, with headquarters in Cavite, P. I.

BARRY DIBBLE, consulting engineer, has completed his contract with the Comisión Nacional de Irrigación of Mexico, covering studies of power possibilities on several irrigation projects that have occupied the greater part of a year, and is again located at Redlands, Calif.

G. M. RIDENOUR has recently accepted a position as research engineer in the New Jersey Sewage Experiment Laboratories. He was previously superintendent of public utilities for the town of Monroe, N. C., and before that was assistant engineer in the bureau of sanitary engineering, North Carolina State Board of Health.

WILLIAM F. COCKE is now city manager of the town of Manassas, Va. Previously he had been with the state highway commission of Virginia, state highway engineer of Florida and since 1923 engaged in contracting in Virginia.

WILLIAM H. DAVIS announces the dissolution of the partnership of Purdy & Davis and that he will continue to practice architecture under the firm name of William H. Davis at 350 Madison Ave., New York. Associated with him will be CHARLES R. GODDARD, formerly construction manager for Purdy & Davis.

ROBERT M. REINDOLLAR, engineer of surveys for the Maryland State Roads Commission, has been promoted to assistant chief engineer. In the new position Mr. Reindollar succeeds HARRY L. WILLIAR, JR., who recently was made chief engineer to succeed John N. Mackall, who resigned. At the same time AUSTIN F. SHURE, district engineer at Chestertown, Md., was promoted to be engineer of surveys and JOSEPH CHANEY was appointed district engineer for southern Maryland, with headquarters in Upper Marlboro.

Dr. ISAAC D. RAWLINGS has resigned as state director of public health of Illinois, a position he has held for several years, and is now assistant health commissioner of Chicago. Pending the appointment of his successor, Dr. Thomas H. Leonard, assistant director, is acting director of public health.

Obituary

CARL S. HOPSTEIN, assistant engineer in the Syracuse, N. Y., office of the state bureau of highways, department of public works, died in Syracuse on March 3. Mr. Hopstein was a member of the engineering firm of Cronin, Card & Hopstein, civil engineers. He was 50 years old.

HENRY W. HAWLEY, president of the Los Angeles (Calif.) Rock & Gravel Company, died on Feb. 15 aged 66 years. As a young man he attained prominence in Utah as a road and railroad construction contractor. In 1913 he organized the Consumers' Rock Company and later the organization which he headed at the time of his death.

CHARLES H. HOWES, retired division engineer of the Massachusetts State Department of Highways, died on March 5 at the age of 74. Mr. Howes built the Mohawk Trail and also the sea wall at the Revere State Reservation. For some years he was in charge of all state highway construction in western Massachusetts.

THOMAS G. DABNEY, father of the Yazoo River delta levee system and one of the best-known flood-control engineers in the Mississippi Valley, died in Memphis on March 5. He was 84 years of age. For more than 50 years he had been active in engineering work along the Mississippi River. From 1884 until a short time before he moved to Memphis five years ago he was chief engineer for the board of commissioners of the Yazoo River Levee District and since going to Memphis had acted as consulting engineer with the workers engaged in building the district's present levee system. As a young man his first levee work in Louisiana brought him into prominence and he was chosen by railroad interests in the Southwest for surveys. Later he was employed by the city of Vicksburg to make a survey of the lower part of the Yazoo River and locate the Yazoo Canal. In 1904 he served for 3½ months as chairman of the California commission of engineers to examine and report on the problem of the reclamation of the valleys of the Sacramento and San Joaquin rivers in California and the rectification of those streams.

Construction Equipment and Materials

Railway Appliances Exhibition at Chicago

The large and varied display of railway machinery, appliances and track materials at the Coliseum in Chicago in connection with the annual meeting of the American Railway Engineering Association presented few new features or devices. There was considerable reduction in the number of highway crossing signals, due probably to gradual progress in the desirable adoption of standard designs. Similar reduction was noted in motor section cars, probably because these are now so well known and so widely used. On the other hand, there were some large and rather elaborate motor inspection cars of the automatic type mounted on special flanged wheels.

A power-operated jacking car which can lift the track for surfacing or ballasting was shown by the Nordberg Manufacturing Company, which had also a tie-adzing machine (for use in track) with rotary cutter on a vertical spindle. Portable air-compressor units for serving pneumatic tools in track work are becoming too large and heavy to be moved on and off the track by hand. Among such machines exhibited the Chicago Pneumatic Tool Company had one equipped with compressed-air jacks by which it lifts itself sufficiently to allow cross-rails to be set under its transverse wheels, the machine being then rolled laterally to or from the track.

Power-driven track tools shown included spike drivers, spike pullers, drills, rail grinders, wrenches and tampers. One of the electric tampers had a special blade or head for tamping gravel ballast. A nut-tightening machine traveling on the track was an interesting exhibit shown by the Woolery Machine Company.

Track material included three designs of substitute ties: the Carnegie H-beam tie, the Dalton oil-rail tie and the Yeomans concrete tie, consisting of two blocks connected by a tie rod. There was the usual large display of switch and frog work. For reconditioning, there was the Electric Railweld Company's machine for building up worn rails in the track and the rolling-mill plant of the Mississippi Valley Structural Steel Company for rerolling worn rails and splice bars. Concrete pipe and wrought-iron and cast-iron corrugated pipe for culverts were shown. Paving for road crossings included metal plates, concrete slabs, asphalt planks and bituminous compositions. An unusual cattle-guard was composed of rows of conical wooden live rollers. Several large machines shown at previous exhibitions were represented by models or moving pictures.

Pipe Company Moves to Restrict Price Cutting

Believing that a distributor who makes a practice of selling well-known merchandise at prices that do not yield him a proper profit is a detriment and not a benefit to the manufacturer and to the distributors who conduct their business on business-like principles, the Reading Iron Company, Reading, Pa., manufacturer of puddled wrought-iron pipe, has adopted a stringent policy with respect to the resale price of its pipe. In the future the company will refuse to make further sales of its pipe to any distributor who shall fail to observe the minimum resale prices suggested by the manufacturer. In order to make clear its legal right to declare and enforce this policy, it quotes on advice of counsel from a decision of the United States Supreme Court which decided that a manufacturer "may withhold his goods from those who will not sell them at the prices which he fixes for their resale."

Business Notes

PHOENIX METER COMPANY, Princes Bay, New York, organized in 1914 and incorporated in 1925, has recently been financially reorganized for the purpose of adequately taking care of its increasing business. Plans are being made for the erection of a new plant. Charles Eisler, newly elected president, is also president and treasurer of the Eisler Engineering Company, Newark, N. J., manufacturer of automatic machinery for the making of radio tubes and allied products. Ernest Gamon, who is vice-president and engineer, has been connected with the meter industry since 1900, founding the Gamon Meter Company in 1909. Previous to that he was engineer and factory manager for the Neptune Meter Company. It is the intention of the Phoenix Meter Company to keep its organization intact and to continue to manufacture water meters exclusively.

NATIONAL TERRA COTTA SOCIETY announces the appointment of William F. Lockhardt as secretary-director, effective March 1, 1929. Mr. Lockhardt's offices will be at 19 West 44th St., New York City.

TOLEDO PRESSED STEEL COMPANY, Toledo, Ohio, announces that final decision was made Jan. 18, 1929, by the United States Circuit Court of Appeals, Sixth Circuit, in the case of the McCloskey Torch Company vs. the Toledo Pressed Steel Company, wherein the McCloskey company appealed the decision of the lower court made May 6, 1927, invalidating patents held by the McCloskey company on a bombshell torch used by contractors for protecting construction work at night. The lower court invalidation was affirmed by the appeal court. It is said that patents held by the Toledo Pressed Steel Company on its torch were not involved in the controversy.

R. A. SHILBAUER, for the past several years assistant advertising manager, Chain Belt Company, Milwaukee, has been appointed advertising manager. Mr. Shilbauer joined the Chain Belt Company as a rate setter in 1920 and later was transferred to the West Milwaukee works, where the company manufactures its general engineering and conveying equipment and concrete mixers and pavers. In 1925 he was placed in the advertising department, where he later became assistant advertising manager, from which position he has just been promoted.

J. D. ADAMS COMPANY, Indianapolis, Ind., announces the acquisition of exclusive sales rights to the crawler dump wagons, automatic wheel scrapers and rotary scrapers manufactured by the Euclid Crane & Hoist Company, Cleveland, Ohio, these sales rights to be operative in most of the Central States, the territory lying west of the Mississippi and the states of Washington, Oregon, Montana and Idaho. The new selling arrangement will permit the Adams company to meet the demand for such equipment as is included in the Euclid line, a demand which the company has experienced in selling Adams graders and Stroud elevating graders to dirt-moving contractors.

SAUERMAN BROS., Chicago, announce the appointment of the Edelen & Boyer Company, Philadelphia, Pa., as their distributor in eastern Pennsylvania and southern New Jersey; also of the Good Roads Machinery Company of New York, Inc., Buffalo, N. Y., for most of New York State, although H. M. Cooper, 152 West 42d St., will continue to look after the company's interests in New York City and surrounding territory.

INTERNATIONAL CEMENT CORPORATION, New York City, announces the appointment of Th. Avnsoe to the office of vice-president in charge of operation and construction. Mr. Avnsoe has been acting as assistant to the president of the corporation.

CHARLES WARNER COMPANY, Wilmington, Del., dealer in lime, sand and gravel, has moved its offices to 1518 Walnut St., Philadelphia, after more than a century of existence in Wilmington. It is stated that negotiations are being completed for the addition to the Warner company of the business and holdings of the Van Sciver Corporation of Philadelphia, another large developer of lime, sand and gravel. About $10,000,000 is involved in the transaction. It is said that the resulting corporation will be the largest firm in its field in the world, controlling the lime, sand

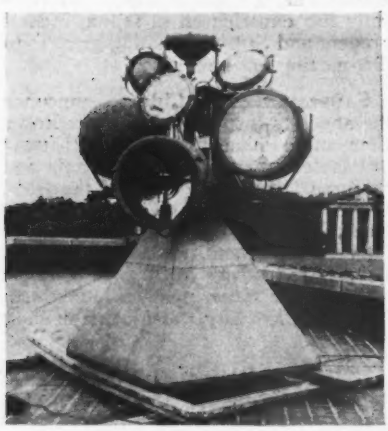
and gravel products business in the Pennsylvania-New Jersey district and in large sections of the neighboring states.

MYRON C. ATWOOD, president and general manager, Western Wheeled Scraper Company, died at his home city, Aurora, Ill., on Feb. 26 after a lingering illness. Mr. Atwood received his early business training in railroad work and was later recognized as an authority in matters pertaining to freight rates and classifications. He became assistant manager of the Western Wheeled Scraper Company in 1906 and in 1910 was promoted to the position of general manager. In 1925 Mr. Atwood became both president and general manager of the company.

New Developments

Fog Penetration Feature of New Airport Beacon

A new form of airport beacon has been erected at the Cleveland municipal airport, the beams of which are said to penetrate fog. As shown in the accompanying illustration, it is a multi-light unit. Several principles of lighting have been incorporated in its design by the National Lamp Works of the General Electric Company. It provides a fan of light which, when rotated, reaches a pilot at any angle at which

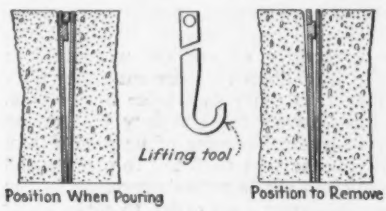


he may approach the field. One half of this fan of light is white, the other half red. The rotation produces alternate red and white flashes, enabling the aviator to distinguish the airport from brightly lighted parks, railroad yards and streets.

The high-intensity beams are projected by the lower, drum-shaped units, of which there are four—two red and two clear—identical in design with those used to mark airways. The upper units, set to project a less intense beam of light at higher angles, are standard narrow-beam floodlight projectors. With the increasing number of airports and because of the fact that on clear nights several may be within sight at a given time from a plane, it is believed that the proper selection of colors for the several units will assist in ready identification of landing areas.

Collapsible Installing Unit for Poured Expansion Joints

A simple device, consisting of collapsible plates, that meets the demand for an economical and practical method of installing poured expansion joints in pavement, slabs and walls has recently been announced by the Electric Welding Company, Pittsburgh, Pa., and designated as its Eweldco joint installing



unit. An example of its method of use in pavement is given in the accompanying illustration. As shown at the left, the unit is pinned on the subgrade in the same manner as is a steel bulkhead. Pouring, finishing and edging operations are carried out in the customary manner, and when sufficient set has resulted, the top bar is removed as shown at the right in the illustration, and the complete unit is withdrawn with the lifting tool. The resulting joint in the slab is then filled with asphalt.

New Centrifugal Pump Made in Three Capacities

The addition of a centrifugal pump to its line of Rex contractors' equipment has been announced by the Chain Belt Company, Milwaukee, Wis. The new pump is made in three sizes with capacities of 325, 650 and 800 g.p.m. respectively on a total head of 20 ft. The features of these pumps are an open impeller which allows the handling of dirty water; an automatically lubricated center bearing; the same size suction and discharge flanges, allowing the use of the same size hose for both; and a unit construction, which assures alignment and rigidity. The addition of this pump makes the company's line unusually complete, since it includes single- and double-diaphragm pumps, single- and double-plunger force pumps and a road pump.

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual convention, Asheville, N. C., April 15-17.

Labor and Materials

Steel Orders Highest This Year

Structural steel orders in the week ended March 5 totaled 74,240 tons, the largest figure for any week this year, compared with 33,450 tons in the preceding week. Inquiries for the week amounted to 36,451 tons, compared with 66,600 tons the week before.

Recent Prices Paid by Cities for Materials

Prices paid by New York City in some recent purchases of standard materials check quite closely with market quotations, as the following tabulation shows.

	Contract Price	Market Quotation
Binder stone, cu.yd.	$2.10	$2.15
Inorganic dust, ton	6.19	6.25
Bituminous road oil, gal.	0.03088	0.055
Pitch joint filler, ton	20.25	20.00
Sand grit, cu.yd.	1.52	1.75

A few current purchase prices in other cities may be of interest. St. Paul and Minneapolis bought respectively 800,000 and 750,000 gal. of road oil at $0.0498 and $0.0492 per gallon. New Brunswick, N. J., paid $5.40 per foot for 4,000 ft. of 4-in. concrete pipe.

Some Boston purchases were: malleable iron castings, $0.0562 per pound, freight prepaid; 50 tons cast-iron bell and spigot pipe in 6-ft. lengths, $80.50 per ton; 50,000 sewer bricks at $17.85.

Milwaukee paid per foot for black steel pipe $1.37 for 2-in., $2.114 for 2.5-in., $2.765 for 3-in., $3.581 for 3.5-in.; and for galvanized-iron pipe, $8.03 for 1-in. and $17.47 for 2-in.

Newark has recently purchased 60,000 ft. of solid copper, rubber-insulated, lead-covered cable at a unit price of 17.53c. per linear foot.

Cost and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1, 1929	**207.78**	**February, 1929**	**378**
Feb. 1, 1929	210.40	January, 1929	325
Mar. 1, 1928	204.65	February, 1928	225
Average, 1928	206.78	Average, 1928	287
Average, 1927	206.24	Average, 1927	263
1913	100.00	1913	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended March 12, with some comparisons, total as follows:

(In Thousands of Dollars)

	Mar. 12, 1929	Mar. 5, 1929	Mar. 13 1928
Building:			
Industrial	$10,524	$4,861	$7,278
Commercial	98,535	36,039	26 825
Streets and roads	5,159	3,143	6,965
Other eng. constr.	46,698	34,185	8,992
Total	$160,916	$78,228	$50,060
Total, all classes, Jan. 1 to Mar. 12:			
1929			$1,000 760
1928			619,220